SWINE GENETIC RESOURCES OF INDIA

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PREFACE

ALTHOUGH piggery contributes substantially to the nutritional and livelihood security of the countrymen, notably rural poor of socio-economically deprived section and womenfolk, yet their role in progressive agriculture has not been captured at appropriate scale. Academically, it can be gauged by the fact that not a single reference book is available that deals with swine genetic resources of India extensively. The book catalogues the veritable goldmine of pig germplasm available in the country that shall serve as a ready-reckoner for those engaged in evaluation, characterization and conservation of indigenous germplasm. The potential of pig genetic resources of the county and their efficient use for breeding program and conservation strategies are delineated.

The production scenario, in-depth description of indigenous pig germplasm, evaluation and characterization of indigenous pig genetic resources, experiences of experimentation with the exotic breeds of pigs in India, chronicle of piggery development programmes and description of the developed crossbreds are included with emphasize on selection and breeding strategies for genetic improvement of pigs in India.

Eighteen varieties of indigenous pigs have been identified based on physical attributes and geographical distribution. Out of these, only three have so far been registered as distinct pig breed. The remaining 15 varities equally holds the promise to be registered as possible pig breeds of the country.

Illustrated or well-documented history of genetic improvement of pigs of the country using exotic pigs is grossly missing. The piggery development programmes carried out by different organizations e.g. Central Government, State Government, Research Institutions and other stakeholders are presented chronologically. Output of different genetic improvement programmes in the form of development of different synthetic and crossbred pigs and their impact are discussed. Finally, an outline of selection and breeding strategies for genetic improvement of pigs for the country in specific is presented. It equally focuses on the conservation strategies for the identified indigenous pig varities and breeds.

We believe that the book will serve as a ready-reference for the graduate and post graduate students of Animal and Veterinary Science, researchers, policy planers, personnel of line departments engaged in piggery development and NGOs. Farmers and entrepreneurs involved in pig and pork production will also find the book equally useful.

Authors

CONTENTS

SECTION-I
Production Scenario and Genetic Resources

1

Pig Production Scenario in India

AMONGST the various livestock species, pig is one of the most important sources of meat besides being most efficient food-converter after the broiler chicken. Pig production in India has enormous potential to upscale and contribute to higher economic gains. Pigs have high fecundity, high feed conversion efficiency, shorter generation interval and relatively smaller space requirement. They are equally adapted to intensive and diversified agriculture. Pig farming has the potential to provide employment opportunities to seasonally employed rural farmers mainly in the rain-fed areas and supplementary income generation to womenfolk in their households for improving living standards. Lately, entrepreneurs have started showing interest in pig rearing, processing, value addition and marketing of pork and pork products. For realizing the potential, this sector requires a thorough understanding, appreciation of the present scenario, meticulous planning, mobilization of resources and training of manpower on a larger scale. Sectoral analysis reveals that the pig farming constitutes the livelihood of rural poor belonging to lowest socio-economic strata who have limited means and access to undertake scientific pig farming with improved foundation stock, proper housing, feeding and management. Therefore, suitable circumspective measures are the need of the hour to popularize the piggery husbandry with adequate technical interventions to modernize this sector and improve the productivity of smaller sized rural pig farms.

Origin and domestication

Origin of the domestic pig belongs to a single wild species *Sus scrofa* that formerly existed throughout Eurasia and also found in North Africa and Nile Valley. *Sus scrofa* is a member of the Suidae family, of the order Artiodactyle. About 25 subspecies of *Sus scrofa* (Annexure-I) have been described and it is assumed that these subspecies have evolved as adaptation to localized climate. Other than these, the sub species *Sus salvanius*, is a smaller size animal, popularly known as pygmy hog, once widely distributed in foothills of the Himalayas and now restricted in Manas National Park of Assam (Annexure-II). The Indian wild pig *Sus scrofa cristatus* is found in sub-Himalayan areas including Shiwalik and Tarai area of northern India.

The establishment of agricultural economies based upon domestic animals began independently in many parts of the world and led to both increase in human population size and the migration of people carrying domestic plants and animals. There are two different opinion regarding domestication of pig. One is that they were independently domesticated at different parts of the world, whereas the other states that pigs were domesticated at one center in western Asia in 7000 BC, which gradually diffused to remaining parts of Asia, Europe and Africa. Virtually nothing is known about the history

of pig domestication in the Indian subcontinent, and a temporal context for when local pig domestication might have occurred remains unexplored.

Although *Sus* remains a widespread component of zooarchaeological assemblages throughout India and Pakistan, they represent such a minor proportion of the domestic and wild fauna recovered (Chattopadyaya, 2002) that the possibility of an autochthonous domestication of *S. scrofa* in India has rarely been considered. Recent genetic data have, however, suggested the possibility of an independent domestication of Indian wild boar. Modern mtDNA data (Larson *et al.*, 2005, 2010; Tanaka *et al.*, 2008) have demonstrated that domestic pigs in India possess unique and highly differentiated haplotypes identical to those found in Indian wild boar. This suggests that Indian domestic pigs were probably not derived either from migrating east Asian or south-east Asian populations or from near eastern or European sources, but were the result of a process of local domestication, though, again, the maternal inheritance of mtDNA means that a non-native paternal origin of these pigs remains a possibility.

In India, domestication was most likely to have been during the Neolithic era and linked possibly with the Harrapan culture of India. Pigs were domesticated before initiation of the civilization of Mohenjo-Daro, probably for meat. The remains of pig were found in very earlier time of evolution in the city of Mohenjo-Daro.

Pig population statistics

According to the 19th livestock census of India, its pig population is 10.29 million in comparison to the world population of 977.02 million (FAOSTAT, 2013; http://faostat.fao.org), which constitutes 1.05% of world pig population. Majority of pig population of the world is in China (48.71%) followed by United States of America (6.63%), Brazil (4.00%), Germany (2.83%) and Vietnam (2.69%) (Fig. 1.1).

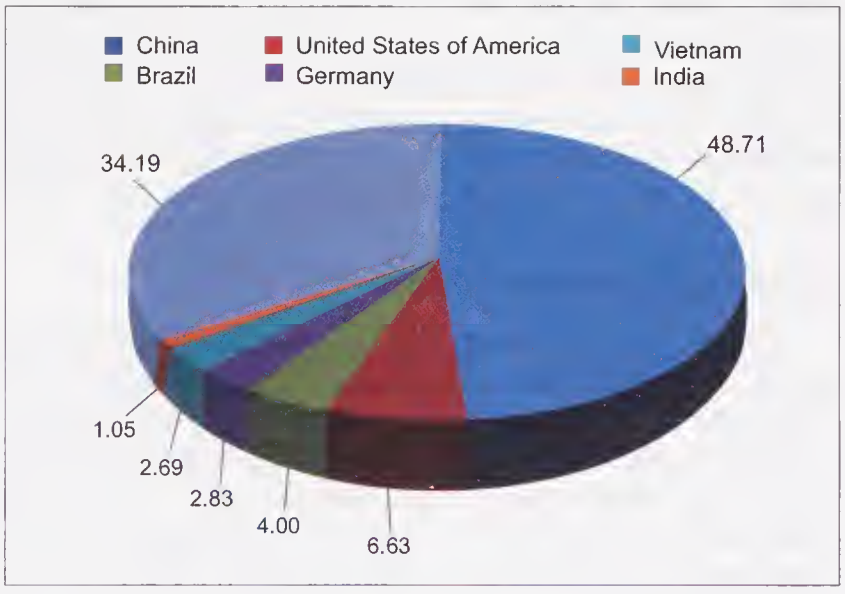

Fig. 1.1. Share of pig population in world (FAOSTAT).

Pig constitutes a mere 2% of total livestock population (512.05 million) of the country (Fig. 1.2). Pig population in India has been increasing gradually since independence except a brief span of recent past. The first livestock census of India in 1951 reported a total pig population of 4.4 million heads which is less than half of the present pig population of the country. Major leap of pig population was 38% between 10th (1966) and 11th (1972) Livestock Census, which was mainly attributed to increased awareness and initiation of breeding schemes in piggery sector of the country (Table 1.1).

Pig population in India witnessed a decline during the last decade (the period between last two censuses) from 13.52 million in 2003 to 10.29 million in 2012. A gradual decrease in population may be necessarily because of diminishing population size of native pigs and increased interest of farmers towards faster growing crossbred pigs like Hampshire crosses in north and north-eastern part, Large White Yorkshire crosses in southern and central part and Tamworth crosses in central and eastern part of India. Enhanced social acceptance of pork and pork products and to mitigate the gap between demand and supply, more number of animals were slaughtered with a slaughter rate of 83.6% (Ranjhan, 2012) resulting in decline in population size. Local epidemic of classified and emerging diseases like classical swine fever, porcine reproductive and respiratory syndrome (PRRS) in north-eastern and other parts of the country are also a major cause of concern for declining pig population over the decadal period.

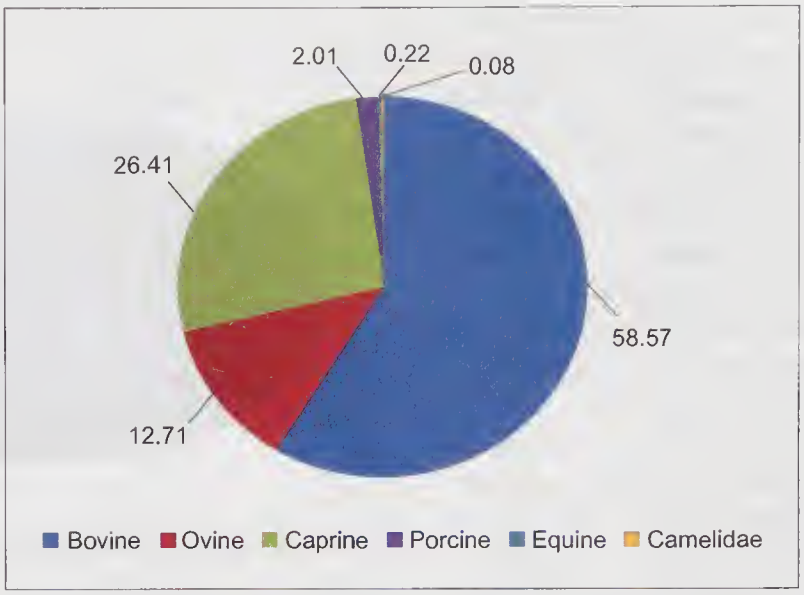

Fig. 1.2. Share of pig population of total livestock (Livestock Census 2012).

The exotic germplasm used for crossbreeding was imported by the country long back. Since then, these animals are being used for different crossbreeding programmes. The decline in population (Table 1.1) may also be affiliated to the increase in inbreeding among the animals in different parts of the country.

Table 1.1. Change of pig population (millions) over the year (1951 to 2012)

Year	Population (million)	% change over last census	Year	Population (million)	% change over last census
1951	4.40	-	1987	10.63	5.56
1956	4.90	11.36	1992	12.79	20.32
1961	5.20	6.12	1997	13.29	3.91
1966	5.00	-3.85	2003	13.52	1.73
1972	6.90	38.00	2007	11.13	-17.68
1977	7.60	10.14	2012	10.29	-7.55
1982	10.07	32.50	-	-	-

(Source: *19th Livestock Census, 2012*)

Distribution

The last livestock census of 2012 demonstrated that pig population is distributed skewedly across the country (Fig. 1.3). The highest pig population is found in eastern (E)

and north eastern (NE) states (63.10%), followed by northern (15.52%), southern (9.48%), central (5.97%) and western India (5.94%). The highest population is in Asom (1.63 million), followed by Uttar Pradesh (1.33 million), Jharkhand (0.96 million), Bihar (0.649 million) and West Bengal (0.648 million). The northeastern part of the country houses 38.42% of the pig population of the country. Indigenous pigs (76.14%) are the cornerstone for pork production in the country followed by crossbred and exotic germplasm (23.86%).

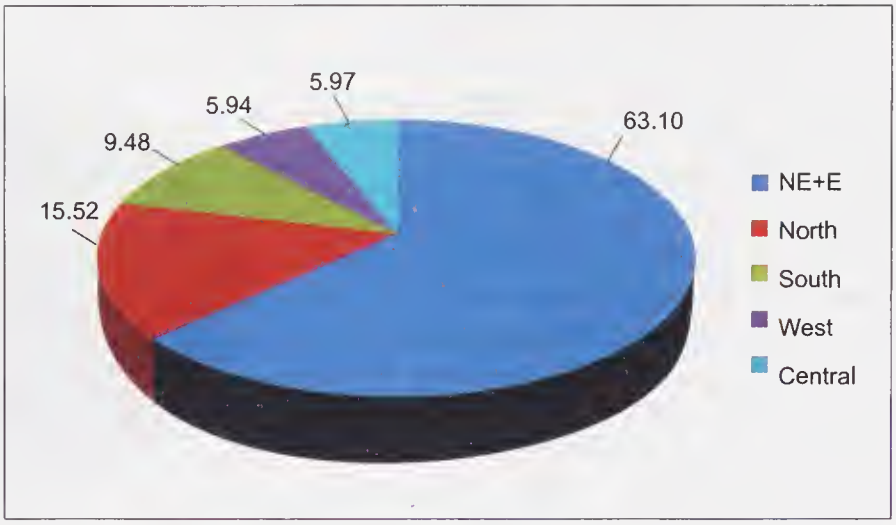

Fig. 1.3. Region wise share of pig population in India (19th Livestock Census, 2012)

Concentration of pig per 100 human population in India is 0.85. Highest concentration of pig per 100 capita is in Arunachal Pradesh (25.77) followed by Nagaland (25.43), Mizoram (22.48), Meghalaya (18.33) and Manipur (10.19) (Table 1.2).

Table 1.2. State-wise pig population in India

State/Union territory	Indigenous (Nos)	Exotic and crossbred (Nos)	Total pig (Nos)	Share (%)	Density/ 100 human population
Andaman & Nicobar	25098	10823	35921	0.35	9.45
Andhra Pradesh	368011	26351	394362	3.83	0.47
Arunachal Pradesh	318976	37369	356345	3.46	25.77
Asom	1022354	613668	1636022	15.89	5.25
Bihar	625531	24182	649713	6.31	0.63
Chandigarh	26	109	135	0.00	0.01
Chhattisgarh	416916	22143	439059	4.27	1.72
Dadra & Nagar Haveli	0	0	0	0.00	0.00
Daman & Diu	14	0	14	0.00	0.01
Goa	37611	5956	43567	0.42	2.99
Gujarat	3394	885	4279	0.04	0.01
Haryana	77153	49792	126945	1.23	0.50
Himachal Pradesh	3090	1943	5033	0.05	0.07
Jammu & Kashmir	1543	878	2421	0.02	0.02
Jharkhand	920625	41742	962367	9.35	2.92
Karnataka	261274	43524	304798	2.96	0.50
Kerala	4965	50817	55782	0.54	0.17
Lakshadweep	0	0	0	0.00	0.00
Madhya Pradesh	161715	13538	175253	1.70	0.24

Contd...

Table 1.2. Concluded

State/Union territory	Indigenous (Nos)	Exotic and crossbred (Nos)	Total pig (Nos)	Share (%)	Density/ 100 human population
Maharashtra	288301	37455	325756	3.16	0.29
Manipur	94669	182546	277215	2.69	10.19
Meghalaya	409758	133623	543381	5.28	18.33
Mizoram	32286	212952	245238	2.38	22.48
Nagaland	122969	380719	503688	4.89	25.43
NCT of Delhi	67765	8581	76346	0.74	0.46
Odisha	276052	4264	280316	2.72	0.67
Pudducherry	534	476	1010	0.01	0.08
Punjab	14465	17756	32221	0.31	0.12
Rajasthan	216589	21085	237674	2.31	0.35
Sikkim	2451	27456	29907	0.29	4.92
Tamil Nadu	153190	30793	183983	1.79	0.26
Tripura	148891	213643	362534	3.52	9.88
Uttar Pradesh	1152441	181951	1334392	12.96	0.67
Uttarakhand	12685	7222	19907	0.19	0.20
West Bengal	595964	52147	648111	6.30	0.71
All India Total	7837306	2456389	10293695	100.00	0.85

(Source: *19th Livestock Census, 2012*)

Changes of pig population during recent times

The pig population declined by 7.54% from 11.13 million in 2007 to 10.29 million in 2012. The trend of change for top 10 states for pig population, which share almost 73% pig population of the country, is given in Fig. 1.4. West Bengal and Asom observed

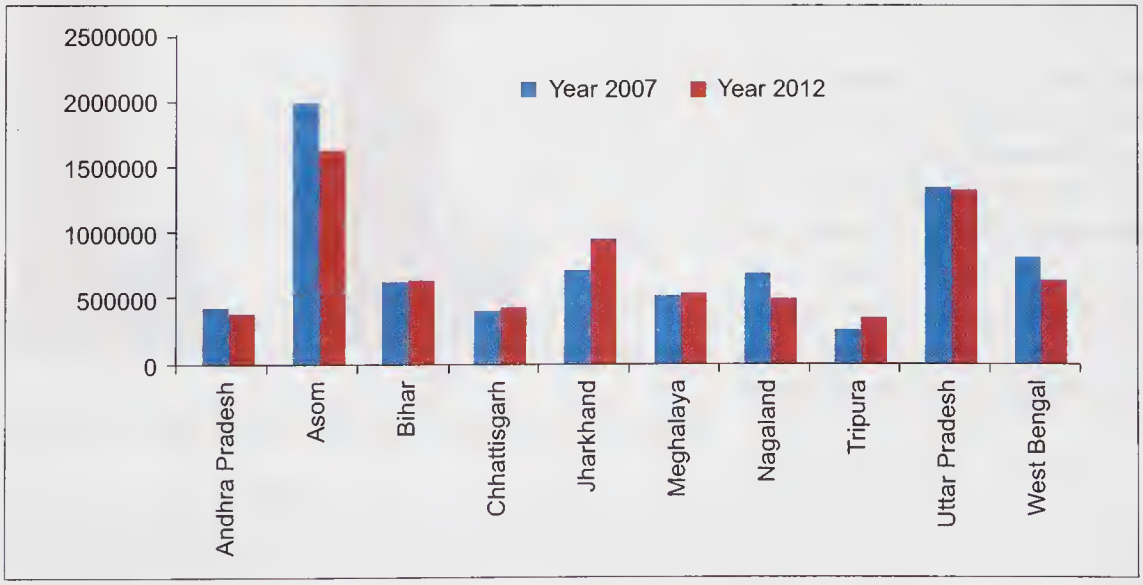

Fig.1.4. Change of pig population in major states over last census

highest decline of 20.44 and 18.22%, respectively, over the last census among the major pig holding states. However, pig population in Bihar, Chhattisgarh, Jharkhand, Meghalaya and Tripura increased, while it declined in Kerala, Madhya Pradesh, Odisha, Nagaland, Mizoram, Manipur, Andaman and Nicobar Island and Tamil Nadu.

Pig germplasm holding pattern

The population of crossbred including exotic pigs (Fig. 1.5) increased 12.66% during the last decade, whereas indigenous pig population declined 30.88% for the corresponding period (Table 1.3). As per last census data, about 89.63% of pig population is reared in rural area whereas only 10.37% is reared in urban and peri-urban areas.

Table 1.3. Decadal share of rural versus urban and peri-urban piggery

Category	2003			2007			2012			Decadal growth rate in % (2003-2012)		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Indigenous pig	9643	1697	11340	7929	816	8744	7100	738	7838	-26.37	-56.51	-30.88
Crossbred and exotic pig	1768	412	2180	2031	358	2389	2126	330	2456	20.25	-19.90	12.66
Total pig	11411	2108	13519	9960	1174	11134	9226	1068	10290	-19.15	-49.34	-23.88

(Source: *Livestock Census, 2003, 2007, 2012)*

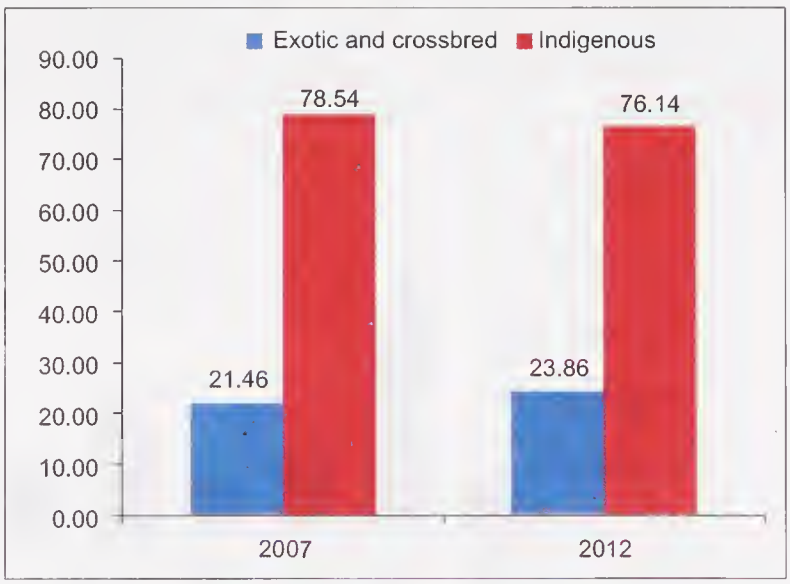

Fig. 1.5. Per cent change of indigenous pig population over last census

Landless and marginal farmers possess most of the pig population of the country. Small- scale production system is the most prevalent and it does not vary widely throughout the country with little or negligible input. Pigs are reared mostly in scavenging system of rearing. However, in north eastern states, Kerala, few districts of Tamil Nadu and West Bengal transformation from backyard system to homestead piggery enterprises is on rise. Further, increase in the number of organized farms as per 19th Livestock Census is a notable feature. It is expected that increased interest for pig husbandry among the progressive farmers and entrepreneurs will boost the scenario of piggery sector of the country.

Pork demand

As per ICMR recommendation, out of 60 g of daily protein requirement for an adult individual, 20 g should be from animal protein source. Considering a modest figure of 20% of total population consuming pork in the country today, and out of 20 g daily animal protein, assuming 10 g from pork source (fish and egg being other major animal protein source); the total pork requirement is around 0.88 million tonnes (20% of 1,210 million human population *i.e.* 242 × 0.010 kg × 365 days) (Banik *et al.*, 2011). Against this, the country as per FAOSTAT, produced 0.33 million tonnes of pork in 2012. Thus, the present shortfall is 0.55 million tonnes or 62.5%.

Pork production

As per FAO datasheet (2012), the share of pork to the total meat production globally was 36.09% followed by poultry (34.93%), beef and carabeef (22.12%) and mutton and chevon (4.55%). In India, maximum meat production was contributed by carabeef (41.73%), followed by poultry (35.89%), mutton and chevon (14.25%) and pork (5.23%) (Fig. 1.6).

Fig. 1.6. Contribution of different livestock species towards total meat production (%)

Out of total 41.90 kg meat consumed per person annually, pork is the most consumed meat in the world with an average 15.80 kg/person/year followed by poultry (13.60 kg), beef (9.60 kg), and mutton and chevon (1.90 kg) (FAO – Food Balance Sheets, 2009). Globally, pork is also the source of more than half of energy (123 kcal/capita/day) derived from food as compared to total energy from meat source (230 kcal/capita/day).

As per FAO statistics, world pork production stood at 109.12 million tonnes in 2012 as compared to a meager 0.329 million tonnes of pork produced in India (Fig. 1.7) that constituted only 0.30% of global pork produced. The yield per animal in India is 35 kg in comparison to a global average of 78.25 kg/animal.

Per capita consumption of pork indicates that it continues to be a preferred choice of meat in many parts of the world, especially in China, Denmark, USA and UK. While the per capita consumption of pork in China is 32.90 kg/year, the corresponding figure for India stands at 0.32 kg (DAHD data and Human Census, 2010).

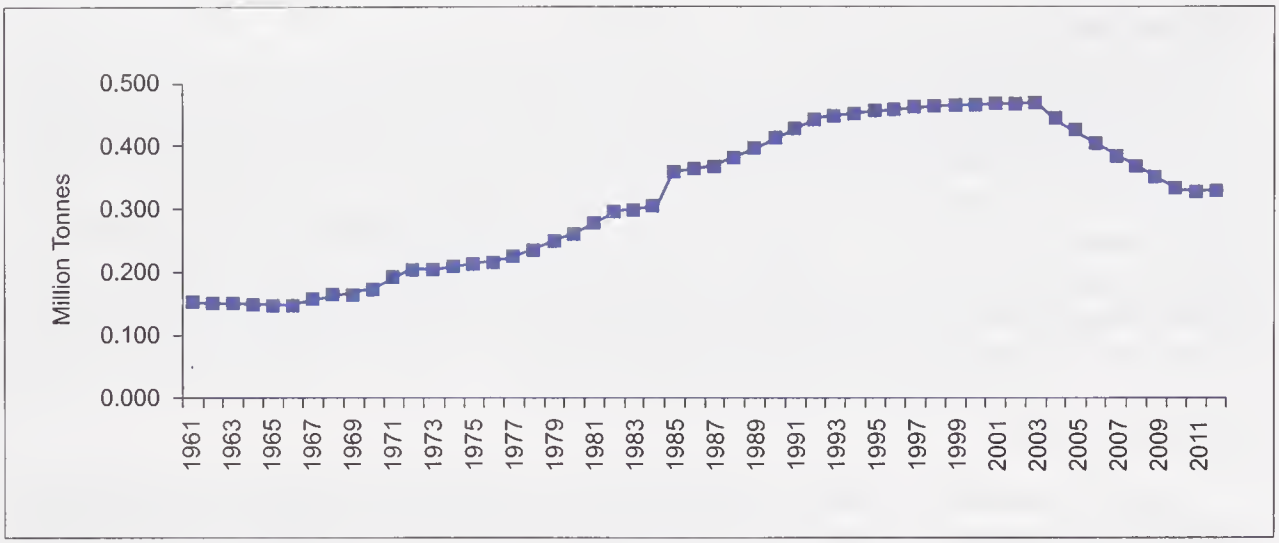

Fig. 1.7. Pork production statistics of India over the years (FAO Data)

Export and import statistics

According to the Agricultural and Processed Food Products Export Development Authority (APEDA), the total export of pork from India was 1,009.92 tonnes (₹ 93.956 million) during 2010-11. In the year 2011-12, export of pork from India was only 305.97 tonnes (₹ 35.141 million). Whereas in the year 2012-13, the export quantity decreased further to 180.63 tonnes (₹ 21.542 million). Cured meat such as sausages, ham, bacon, canned meat products and small quantities of frozen meat are some of the products included in these exported stuffs. The export was made to countries like Thailand, France, Vietnam, Bhutan and South Africa. The downturn in export of pork from India may be due to an increased demand within the country fuelled by economic prosperity along with increased social mobility.

Import of value added pork products has registered an increase in recent years. It was mainly sourced from Belgium, Italy, Netherlands, Spain and Chili. The import increased due to augmentation of domestic demand of quality pork products as well as increased arrival of foreign tourist.

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2

Indigenous Pig Germplasm of India

INDIGENOUS and non-descript pig breeds constitute 76.14% of the total population of 10.29 million of pigs of the country (Livestock Census, 2012). These breeds/varieties are distributed throughout the country with different morphometric traits and production parameters. Most of them are yet to be characterized with appropriate scientific tools. These pigs are of smaller size, and little effort has been made for their conservation and selection to improve the economic traits, such as litter size, birth weight, weaning weight, average daily gain, feed conversion efficiency and carcass traits. They are well adapted to hot and humid climate and were found to have better disease tolerance. Prolificacy and adaptability to low management inputs are excellent characters of these pigs. In some regions of the country, local pigs are well preferred over the exotic and crossbred pigs due to quality and taste of pork and their tolerance to the diseases. As a unique feature, some of these native pigs mature at an exceptionally early age. Though these pigs are less or moderately prolific but possess good mothering ability, which directly influence the survivability of their piglets during younger age.

The indigenous pigs of India are identified as a distinct group owing to gradual domestication of wild pigs to their surroundings. They differ in characteristics and attributes from region to region within the country depending on the topography and climatic conditions. Following native/indigenous pigs are found in the country:

1. Agonda Goan
2. Andaman Local
3. Andaman Wild
4. Ankamali
5. Burudi
6. Dome
7. Doom
8. Ghungroo
9. Golla
10. Lepchamoun
11. Mali
12. Manipur Local
13. Niang Megha
14. Nicobari
15. Pondi
16. Purnia Desi
17. Tenyi Vo
18. Zovawk

Among the available indigenous germplam, only six breeds namely Ghungroo, Niang Megha, Agonda Goan, Nicobari, Tenyi Vo and Doom have been registered as breed in national database. The available information of indigenous pig germplasm is described here and performances of the registered breeds are given in Table 2.1.

Other than these specific breeds and varieties, a large population of non-descript pig exists in different pockets of the country. These huge chunks are the major contributors to indigenous pig population in India. There is an immediate need to document and characterize all the available pig population of the country (*see* Chapter 3).

Table 2.1. Performance of registered breeds of India

Traits	Ghungroo	Niang Megha	Agonda Goan	Tenyi Vo	Nicobari	Doom
Litter size at birth (no)	10-11	6-7	7-8	5-6	6-7	6-7
Litter size at weaning (no)	8-9	5-6	6-7	4-5	5-6	5-6
Body weight at birth (kg)	0.96	0.64	0.60	0.31	0.61	0.66
Body weight at weaning (kg)	5.69	4.32	4.55	3.50	4.78	3.15
Body weight at 3 months (kg)	11.38	7.79	7.62	6.85	9.62	7.42
Body weight at 6 months (kg)	38.84	27.62	27.81	13.00	26.47	27.92
Body weight at 8 months (kg)	60.66	48.24	43.24	27.50	50.12	40.48
Body weight at 12 months (kg)	75.26	63.38	61.23	35.23	62.32	59.22
Dressing percentage	69-70	70-72	70-72	68-70	72-76	75-77
Back fat thickness (cm)	3.2	2.2	4.5	1.6	5.5	2.8

Agonda Goan

Habitat: The breeding tract of Agonda Goan pig is spread mostly over Agonda region of northern Goa. The breed is also available in other parts of the state. The latitude and longitude of the breeding tract is 14°5' to 15°4' north and 73°4' to 74°2' east, respectively. The area features a tropical monsoon climate and has a hot and humid climate for most of the year. The average temperature ranges from 19° to 33°C with an annual average rainfall of 2,926 mm.

Physical appearance: The breed is semi-wild in nature. The animals are small in size with predominantly black coat; coat matt type and uniformly covered with bristles; occasionally white patches on head and legs. They have short snout with short erect ears. Top line is slightly convex. Six to ten pairs of teats are situated at mid ventral line. Tail is medium in size (Fig. 2.1).

Management system: Animals are maintained traditionally in backyard system (Fig. 2.2). Scavenging system is also seen (Fig. 2.4). Average flock size ranges from 5 to 20. Mostly animals are let loose to the forest for grazing. Some farmers have housing made up of locally available stone and roof covered with plastic and coconut leaves (Fig. 2.3). Kitchen and hotel wastes are collected and boiled before providing to animals. Besides supplying pork for local sausage market, mostly farmers rear the animal for slaughter or sell during festive season like Christmas and New Year.

Productive and reproductive performance: The average body weights of Agonda Goan pig at birth, weaning and adult age are 0.63, 2.77 and 39.81 kg, respectively. The overall mean heart girth, height at back leg and body length of the adult animal are 86.48, 55.87 and 101.49 cm, respectively. Average litter size at birth and weaning is 7.45±0.51 and 5.90±0.55, respectively. Age at first heat and age at first farrowing are 129.35±7.85 and 334.75±27.32 days, respectively. Inter-farrowing interval is 185.35±4.11 days. The sows have good mothering ability and strong maternal instinct. Nursing sows are difficult to handle, and may even attack strangers.

The dressing percentage of the adult animal is 72% with an average back fat thickness of 4.94 cm.

Agonda Goan pig is a recognized pig breed of India with Accession No: INDIA_PIG_3500_ AGONDAGOAN _09003.

Fig. 2.1. Agonda Goan **(a)** Male pig; **(b)** Female pig; **(c)** Grower pigs; **(d)** Pig under field condition

Fig. 2.2. (a) Feeding tub at farmer's backyard; **(b)** Feeding practice at farmer's backyard

Fig. 2.3. (a-b). Glimpses of housing of Agonda Goan pigs

Fig. 2.4. (a-b). Pigs in scavenging system at forest

Andaman local

Habitat: The Andaman local pigs are mostly found at Baratang and Mayabander taluka of north and middle Andaman districts. The breeding tract extends from 10° to 14° north latitude and 92° to 94° east longitude. The mean temperature of the area varies from 25° to 31°C with an annual rainfall of 3,155 mm. The habitat is mostly plain.

Physical appearance: The animals are mostly black. Long shiny backwardly curved bristles and long tail for both the sexes are unique characters for this breed. Ears are comparatively bigger and erected upward (Fig. 2.5).

Management system: The animals are raised by backyard system with low input (Fig. 2.6). These pigs thrive well with low-plane of nutrition. Pigs are fed with locally available feed material viz. rice bran, maize, wheat, coconut, taro (*Colocasia*), tapioca, kitchen waste and poultry offals. No major disease incidences are reported. A large number of these pigs were lost during Tsunami in the year 2004.

Productive and reproductive performance: Adult body weight is about 65 kg in male and 60 kg in female. The age at first farrowing is about 300 days and litter size of about 7 to 9 numbers. They are docile and comparatively lesser alert than other pigs.

Fig. 2.5. (a-d). Andaman; **(a)** Local Pig with litter; **(b)** Local pig; **(c)** Local sow; **(d)** Local piglet

Fig. 2.6. (a). Andaman Local at farmers' field

Fig. 2.6. (b). Housing for Andaman Local at field

Andaman Wild

Habitat: The Andaman Wild pig, an endangered pig germplasm of Andaman and Nicobar Islands, is available since time immemorial in the Jarawa reserve forest area. This wild variety of pigs is found in the Andaman group of islands in general and little

and middle Andaman in particular. The breeding tract extends from 10° to 14° north latitudes and from 92° to 94° east longitudes. The average mean temperature of the area varies from 25° to 31°C with an annual rainfall of 3,155 mm. The habitat is mostly plain.

Physical appearance: These are short and sturdy pigs. The colour varies from black to grey. White patches on different parts of body are also seen. They are very agile, sensitive and wild in nature. Ears are erect. Legs are short and placed wide apart (Fig. 2.7).

Management system: They are free ranging type and generally no housing is provided to them. They are often hunted for their meat. They feed with wild fruits and tubers in jungle. Their number is declining because of hunting by primitive Jarawa tribes. Pork from these animals is the main animal protein source for Jarawa tribes. However, these pigs are also protected under Wildlife Protection Act of India (1972).

Productive and reproductive performance: Average height at shoulder and back are 50 and 60 cm, respectively. Body weight varies between 16 to 30 kg.

Fig. 2.7. (a). Andaman Wild boar

Fig. 2.7. (b). Andaman Wild sow with litter

Ankamali

Habitat: The breed is named after its main breeding tract located at Ankamali block of Ernakulum district of Kerala. Lying between north latitudes 8°18' and 12°48' and east longitudes 74°52' and 77°22', the breeding tract experiences the humid equatorial tropical climate. Annual rainfall averages around 3,107 mm, with most of the precipitation occurring between June and August. Temperature ranges from 22° to 34°C. In addition to its native tract, pigs of this breed are also seen in other parts of Kerala and adjoining states of southern peninsula viz. Karnataka, Tamil Nadu, and few parts of Maharashtra and Andhra Pradesh.

Physical appearance: The pigs are mostly black with white patches at extremities. Body is small to medium size with pot bellied appearance. Face is long and tapering. Thick and long bristles are present over the neck and vertebra which become thinner and smaller in length towards the belly. Ears are medium sized and erect. The tail is usually long and thin with tuft of hair at the extremity (Fig. 2.8 a, b, c).

Management system: Generally pigs are raised in backyard system and looked after by womenfolk and children. Mostly boars are kept separately while sows and growers are kept together. Wood and bamboo made enclosure is commonly used for housing the animals. Occasionally concrete and mud are used to prepare flooring material and corrugated tin or asbestos is generally used as roofing material. Kitchen waste supplemented with agricultural byproducts is fed to the animals. Ingredients like maize, wheat, chopped and boiled banana stems, tapioca tubers and leaves are also used as feed material based on their availability (Fig. 2.8. d).

Productive and reproductive performance: The average body weight of Ankamali pig at birth, weaning and adult stage ranges from 0.44±0.01 to 0.78±0.01 kg; 7.00±0.36 to 8.12±0.18 kg and 31.32±0.45 to 42.91±1.04 kg, respectively. Male pigs are usually heavier in weight during birth and at adult age than their female counterparts.

The age at first fertile service ranges between 261.5 and 278.5 days. Results from three units of AICRP on Pig located at Tirupati (Andhra Pradesh), Mannuthy (Kerala) and Kattupakkam (Tamil Nadu) showed that the range of average age at first farrowing was between 375.2 to 386.8 days. The range of mean gestation length was 109.8 to 111.6 days. Litter size at birth and weaning ranged from 4.92 to 5.38, and 4.20 to 4.73, while

Fig. 2.8. (a). Ankamali boar

Fig. 2.8. (b). Ankamali grower pig

Fig. 2.8. (c). Swill feed for pig

Fig. 2.8. (d). Ankamali nursing sow with piglets

litter weight at birth and weaning ranged from 2.13 to 5.21 and 32.12 to 37.81 kg, respectively.

These pigs are known for production of lean meat under backyard or scavenging system. Dressing percentage of the breed varies from 67.6 to 75.03% with moderately lower back fat thickness of 1.7 to 2.8 cm.

Burudi

Habitat: Burudi pigs are found in Koraput and adjoining districts of Odisha. The breeding tract is spread over 17°52 to 20°32 north latitude and 81°22 to 84°12 east longitude. The average rainfall of native tract is 1,500 mm, experienced as the result of south-west monsoon during July to September. Temperature ranges from 5° to 35°C.

Fig. 2.9. Burudi pig

Physical appearance: The animals are small in size. They are mostly black with white patches at the extremities. Brown colour is not uncommon. They are pot bellied in appearance, and have short legs. The tail is short hanging up to knee and has a tuft of hair at the end (Fig. 2.9).

Management system: The animals are mainly reared through scavenging system within the village. However, they are poor grazer. Locally available feed ingredients like rice bran along with kitchen waste are offered to the animals.

Productive and reproductive performance: The adult body weight is approximately 30 kg. The animals are moderately lean with less back fat thickness. They are prolific breeder and give two litters per annum on an average. Litter size ranges from 8 to 12 numbers of piglets. Most piglets at birth have reddish and black longitudinal stripes over the body.

Dome

Habitat: Dome pigs are mainly concentrated in Kanchanpur sub-division of north Tripura district and adjoining areas. The breeding tract is located between 22°56' and 24°32' north latitude and 90°09' and 92°20' east longitude. Temperature of this area varies from 10° to 37°C. The area experiences a tropical climate and receives annual average rainfall of 2,100 mm.

Physical appearance: Animals are small and pot bellied in appearance. Colour varies from black to grey. White spots at extremities are also found. Long and thick crest bristles are found on the back line. The snout is long; ears are short and erect. Four to six pair of teats along the mid-ventral line is found in female pig (Fig. 2.10 a, b, c, d, e, f).

Management system: Animals are commonly raised in backyard system, although semi-intensive system of rearing is gradually becoming popular (Fig. 2.10d). Animal house is commonly made with concrete floor with bamboo wall and thatched roof (Fig. 2.10f). Rice bran, fermented rice and dry fish are the major feed ingredients offered to the animals. They are believed to be tolerant to diseases as incidences are reported to be very low.

Fig. 2.10. (a). Dome pig

Fig. 2.10. (b). Dome sow

Fig. 2.10. (c). Dome grower pigs

Fig. 2.10. (d). Sow at farmers' field

Fig. 2.10. (e). Dome Sow

Fig. 2.10. (f). Housing of Dome pig

Productive and reproductive performance: Adult body weight is about 50 kg in male and 45 kg in female. Litter size varies from 8 to 10 at birth and 7 to 9 at weaning. The animals attain adult body weight in a year.

Doom

Habitat: Breeding tract of the Doom pig is spread to most parts of Asom. However, animals of this breed are predominantly found in Agamoni and Golokganj areas of Dhubri district of Asom bordering West Bengal. The latitude and longitude of the breeding tract is 24° 8' to 28° 2' north and 89° 42' to 96°' east. The average temperature ranges from 6° to 38°C with an annual average rainfall of 1,600 mm.

Physical appearance: Animals are of medium size with stout body. They are predominantly black with long snout and small ears. Bristle is thick and long and spread from head to back along the spine (Fig. 2.11a, b, c, d). At 8 months of age, average body length, height at withers and heart girt is 71.2 cm, 56.26 cm and 73.4 cm, respectively.

Fig. 2.11. (a). Adult Doom female

Fig. 2.11. (b). Adult female with piglets

Fig. 2.11. (c). Doom piglets

Fig. 2.11. (d). Doom flock under field condition

Fig. 2.11. (e). Feeding of pigs

Fig. 2.11. (f). Preparation of banana stem for feeding

Fig. 2.11. (g). Flock of Doom pigs in scavenging

Fig. 2.11. (h). Doom boar in scavenging

Fig. 2.11. (i). Housing of pig

Fig. 2.11. (j). Bamboo enclosure for pig

Fig. 2.11. (k). Slaughtering

Fig. 2.11. (l). Marketing of pork

Management system: The animals are reared under backyard as well as scavenging system. Mostly animals are kept in scavenging system (Fig. 2.11 g, h). Sometimes they are tied with trees. In some cases, the tribal houses are made on a height of 3 feet above the ground and pigs are sheltered on the basement (Fig. 2.11 i). In few incidences, separate enclosure is made with bamboo wall nearby dwelling of farmer (Fig. 2.11 j). A sizable population of this breed is also available with nomads who move with their animals in search of food and other resources throughout the year. No specific housing is provided to these animals. While moving from one place to another, animals take shelter under trees. Mating takes place while roaming within the herd. A herd comprises 50 to 150 animals. There is also a practice of interchanging breeding boars between herds.

Pigs are kept by scavenging with supplementation of kitchen waste and vegetables (Fig. 2.11 e). In semi-intensive system, farmers occasionally feed their pigs with end product of fermented rice beer (*jugli*) and locally available cooked vegetables like cabbage, potatoes, green leafy vegetables, rice beer (*mera*) and banana stem (Fig. 2.11 f).

Productive and reproductive performance: The adult body weight of male and female ranges between 36 to 40 kg and 38 to 42 kg, respectively. Litter size at birth and weaning is 3.93 and 3.2, respectively. Litter weight at birth and weaning is 3 and 35 kg, respectively.

Doom pig is the sixth recognized pig breed of India with Accession No: INDIA_PIG_0200_ DOOM _09006.

Ghungroo

Habitat: The breeding tract of this pig spreads over northern part of West Bengal and adjoining districts of Asom, Sikkim, Nepal and Bhutan. The breed is predominantly found in Jalpaiguri, Darjeeling, Cooch Behar, North Dinajpur and South Dinajpur districts of West Bengal. This area comes under Tarai and Dooars area of sub Himalayan region and typically characterized by forest and tea gardens. The latitude and longitude of the breeding tract is 24° to 27° north and 88° to 89° east, respectively. The average rainfall varies from 1,600 to 3,200 mm. Temperature of this region varies from 7° to 38°C.

Physical appearance: It is a medium size breed which is also the longest among the reported Indian pigs with a long and cylindrical barrel and triangular large drooping ears. The colour is predominantly black with scanty hair and soft bristles at backline. Occasional white patches at fore head, front and hind feet are also present. Their skin becomes heavily wrinkled with the advancement of age (Fig. 2.12 a, b, c, d). Bulldog type face with folded skin is a typical breed characteristic (Fig. 2.12 e). The animal bears 6 to 9 pairs of cup type teats at mid-ventral line. The body line is straight in male and slightly concave in female. Tail is small to medium size and extended up to hock joint.

Management system: The breed is highly docile and amenable to any form of management practice. The sow shows good mothering ability. In the breeding tract, farmers manage their animals under stall-feeding and grazing system (Fig. 2.12 g). Herd size at farmers field ranges from 1 to 5 breedable females. The animals are commonly pegged during the day time and provided with night shelter, which is made up of locally available cheap material viz. bamboo and wooden planks. Sometimes a group of animals are kept together and marketed at the same time depending upon the demand.

In the breeding tract, feed stuff used for stall feeding consists of rice husk, rice gruel, kitchen waste, fish offals and discarded chicken viscera. Mostly broken rice and rice husk

Fig. 2.12. (a). Ghungroo Boar

Fig. 2.12. (b). Ghungroo sow

Fig. 2.12. (c). Ghungroo sow with piglets

Fig. 2.12. (d). Ghungroo grower pigs

are boiled and offered to the animals. Community slaughter is practiced in the breeding tract without much hygienic method. Pork is sold in open areas (Fig. 2.12 f).

Productive and reproductive performance: The average body weights of Ghungroo pig at birth, weaning and adult age are 0.96±0.02, 6.15±0.21 and 78.66±2.05 kg, respectively. Males show slightly higher body weight at birth and adult age than the females. The average pre-weaning growth rate is 113 g/day.

The mean heart girth, punch girth, height at shoulder, height at back, height at foreleg, height at back leg and body length of the adult animals is 114.74±2.29, 127.74±2.57, 60.25±0.97, 63.00±0.95, 35.23±0.70, 37.48±0.71 and 124.28±2.40 cm, respectively.

The breed is highly prolific. Average litter size at birth and weaning is 10.02±0.35 and 8.20±0.23, respectively. A litter size of 18 piglets at birth is not uncommon in this breed. Age at first heat and age at first farrowing are 190.38±4.38 and 303.33±4.41 days, respectively. Inter-farrowing interval is 169.0±4.88 days. Dressing percentage of the adult animal is 70.8%, with an average back fat thickness of 4.59 cm.

Ghungroo pig is the first recognized pig breed of India with Accession No: INDIA_PIG_2100_GHOONGROO_09001.

Fig. 2.12. (e). Typical bulldog shaped face

Fig. 2.12. (f). Pork sale in breeding tract

Fig. 2.12. (g). Ghungroo pigs at backyard system

Golla

Habitat: The breeding tract of Golla pig is undivided Ganjam district of Odisha. The latitude and longitude of the breeding tract are 19° to 20°172 north and 84°92 to 85°12 east. The average rainfall is 1,444 mm, experienced due to south west monsoon during June to September. Being the coastal district, the temperature remains almost uniform throughout the year and ranged between 20° to 35° C. The name of the breed came after its rearer i.e. Golla community.

Physical appearance: The pigs are medium in size and black. Head is small and compact. The abdomen is parallel. The neck is short and stoutly built; ears small; legs strong and stout; tail medium in length with tuft of hair at the end. Males have a row of erect bristle running over the neck and thorax. The skin is thick. The animals are fleshy in appearance (Fig. 2.13 a).

Management system: The herd tends to flock around the village and feed through scavenging (Fig. 2.13 b). They have comparatively strong snouts, thus penetrate deep into the ground bed in search of tuber food. Animals can thrive in very low level of nutrient. They are efficient converter of non-conventional feeds to nutritious pork, which is attributed to its long gut and superior digestion capacity. The piglets move with the flock. They walk fast, and almost run during grazing or scavenging time.

Productive and reproductive performance: Average body weight ranges between 40 to 60 kg. They mature early and give 9 to 10 piglets/litter with two litters a year being quite common. The breed has superior litter size, which is further exploited with feed supplement. Attributed to its high fecundity at low plain of nutrition, the breed is considered highly valuable by their rearers.

Fig. 2.13. (a). Golla pig

Fig. 2.13. (b). Golla pig scavenging

Lepchamoun

Habitat: The breeding tract of Lepchamoun pigs is in Sikkim. The latitude and longitude of the breeding tract is 28°072 to 27°042 north and 88° to 88°552 east. The climatic conditions vary from tropical to alpine. The day temperature varies between 15° to 28°C during summer, while temperature reaches as low as 6° to 7°C during winter. The rainfall varies from 3,000 to 4,000 mm. The breed is mainly reared by local tribes.

Physical appearance: The breed is black and small in size. Body is covered with long bristles. Ears are large as compared to other breeds and drooling (Fig. 2.14 a, b, c, d).

Management system: Lepchamoun pigs are commonly reared under backyard system by the tribal people of Sikkim. The kitchen waste and locally available feed ingredients, namely wheat bran, pseudostem of banana and tuber, stem, shoots and leaves of different plants are used as feed for these animals. Napier, chocho, and other soft palatable grasses are also fed to animals. Cooked feed is offered to pigs. Low-cost pig sty made of locally available materials viz. bamboo and wooden plank is used for housing. Farmers use bamboo or wooden floor and thatched roof for housing in most of the cases (Fig. 2.14 e, f).

Productive and reproductive performance: The litter size at birth and weaning of this breed is 4.3±0.45 and 2.79±0.24, respectively. Individual piglet weight at birth and weaning is 0.49±0.31 and 4.90±0.33 kg, respectively. Body weights of adult male and female pigs range between 45 and 55 kg, and 50 and 60 kg, respectively. The animals are docile and lethargic in nature and have very good mothering ability.

Fig. 2.14. (a). Adult Lepchamoun pig

Fig. 2.14. (b). Grower animals

Fig. 2.14. (c). Lepchamoun piglet

Fig. 2.14. (d). Lactating sow with litter

Fig. 2.14. (e). Housing

Fig. 2.14. (f). Pig shed

Mali

Habitat: The breeding tract of Mali pigs is in Tripura and adjoining area. Tripura West, Tripura South, Tripura North and Dhalai districts are the main breeding tracts of these animals. The breeding tract is located between 22°56' and 24°32' north latitude and between 90°09' and 92°20' east longitude. Temperature of this area varies from 10° to 37°C. The area has a tropical climate and receives annual average rainfall of 2,100 mm.

Physical appearance: Animals are medium sized and black with compact body and short legs. The coat is covered with coarse thick bristles. White spots at the extremity of legs are common. Ears are short and erect. The face is narrow with an upwardly curved snout. The animals have medium-size hindquarters and drooping rumps. Sows have 4 to 6 pairs of teats along the mid ventral line of body (Figs. 2.15 a, b, c, d).

Management system: Animals are commonly raised in semi-intensive system (Figs. 2.15 e, g). *Kaccha* housing is a common practice in field. Locally available bamboo and wooden (Figs. 2.15 i, j) planks are used as housing material. Rice bran, fermented rice, dry fish are the major feed ingredients for these animals (Fig. 2.15 f). Locally available turnip and colocasia are also offered to animals after boiling.

Males are aggressive and sows have strong mothering abilities. Nesting behaviour is common in sows under village conditions (Figs. 2.15 i, j) before and after farrowing. Sows are very difficult to handle during peri-parturition period.

Productive and reproductive performance: Average litter size at birth and weaning is 8.6±0.4 and 7.5±0.3, respectively. Body weights at birth, weaning and adult age are 0.47±0.2, 4.0±0.1 and 73.4±0.7 kg, respectively. The breed attains early sexual maturity (138.3±6.4 days in males and 117.9±1.5 days in females).

The overall mean heart girth, height at shoulder and body length of the adult animal are 120.0±0.2, 65.4±0.3, and 66.7±0.7 cm, respectively. Slaughter by hitting head with heavy and/or sharp object followed by heart puncture is practised at farmers' field.

Fig. 2.15. (a). Nursing Mali sow with litter

Fig. 2.15. (b). Mali boar

Fig. 2.15. (c). Mali grower pigs

Fig. 2.15. (d). Mali sows with its litter

Fig. 2.15. (e). Mali pig under field condition

Fig. 2.15. (f). Collection of feed

Fig. 2.15. (g). Feeding under field conditions

Fig. 2.15. (h). Adult Mali pig at organized farm

Fig. 2.15. (i). Mali piglets at organized farm

Manipuri Local

Habitat: This breed is commonly found in Ukhrul, Imphal East, Tamenglong, Churachandpur and Senapati districts of Manipur. The breed is predominant in the villages on the east side of the Ukhrul district bordering Burma, e.g. Kamjong. The pig breed is also available in Moreh and some adjoining villages. The breed is also known as Chingoak and Haohok. The latitude and longitude of the breeding tract is 24° to 27° north and 88° to 89° east. The average rainfall is 1,467.5 mm mostly received May and mid-October. Temperature in the region varies from 0° to 36°C.

Physical appearance: It is a small size breed, usually black with occasional white spots on the forehead. Face is small and elongated with small and erect ears. The dorsal body line of animals is slightly curved. Animals have pot bellied appearance. Body is covered with thick bristles (Figs. 2.16 a, b, c).

Management system: The breed is mostly reared by the tribal communities in backyard system. Few animals are also raised in scavenging system which is declining. Cooked banana stem mixed with locally available edible tree leaves, rice husk, kitchen waste are the major feed stuffs fed to these animals (Fig. 2.16e). The ingredients are boiled and offered to the animals.

Fig. 2.16. (a). Adult female pigs of Manipuri Local

Fig. 2.16. (b). Adult female and grower pigs

Fig. 2.16. (c). Growers Manipuri Local

Fig. 2.16. (d). Housing under field conditions

Fig. 2.16. (e). Feeding material

Fig. 2.16. (f). Slaughtering of pig

Housing is mostly made up of wooden planks, small tree logs and branches (Fig. 2.16 d). Farmers commonly maintain breeding boar for their flock. No major disease outbreaks are encountered and the animals are reported to be disease-tolerant. Practically no vaccination coverage is provided to the animals.

Productive and reproductive performance: Body weight of adult male and female animals varies between 60 and 70 kg and 55 and 60 kg, respectively. Marketing age is 1 year and weight varies from 50 to 65 kg, respectively. Litter size at birth and weaning range between 5-6 and 4-6, respectively. The animals farrow twice in a year and average litter weight at birth is 1.5 kg.

The farmers practise weaning at around 3 months of age with a litter weight of 16 to 36 kg. Growth rate is usually lower. Slaughtering is done manually in traditional ways at unorganized slaughter houses (Fig. 2.16 f). The head of the animal is hit with blunt heavy objects like non-sharp end of an axe, iron rod, hard wooden logs etc. followed by heart piercing with a sharp bamboo stick. Local people prefer pork produced from this native pig, which is perceived as more tasty. Farmers also share pigs as gift during festive season.

Niang Megha

Habitat: The breeding tract of Niang Megha pig consists of the Khasi, Garo and Jayantia hill ranges of Meghalaya. The pig is found in almost all parts of Meghalaya, but the mountainous areas are major breeding tract of these animals. The breed is also known as Khasi local, Garo local, Meghalaya local, Niang Khasi by the rearers. The breeding tract extends from latitude and longitude of 25° to 26°42 north and 89°52 to 94°42 east, which consists of East Garo Hills, East Khasi Hills, Jaintia Hills, Ri-Bhoi, South Garo Hills, West Garo Hills and West Khasi Hills. With an average annual rainfall as high as 1,200 cm in some areas, the temperature varies from sub-zero to 28°C. The breed is mainly reared by Khasi, Garo and Jaintia tribes of the state.

Physical appearance: Animals of this breed are of small to medium size with a bright wild look. They are mostly black with white patches on forehead commonly diamond or star shaped at underbelly parts, below the hock joint and switch. Coat is glossy, uniform and densely covered except midline, which is thickly covered with bristles. The breed is pot-bellied with ventral line almost touching the ground. Face is concave and tapering at the middle with small vertically extended ears. Tail is small to medium size and extend up to fetlock joint. The animal bears 5 to 7 pairs of teats along the mid ventral line (Figs. 2.17 a, b, c, d, e, f).

Management system: Pigs of both the sexes are ferocious, specially breeding male and nursing sows. The female have good mothering ability. In the breeding tract, farmers rear these animals by grazing and backyard production system with a flock size of one to five sows. Mostly the pigs are reared by women of a family. Pig house is made up of locally available bamboo or wooden planks. Animals are commonly housed during night only. Sometimes they are housed at the basement of traditional dwelling unit of livestock owner. Most of the pigs are reared under backyard system with supplementation of kitchen waste.

Fig. 2.17. (a). Niang Megha boar

Fig. 2.17. (b). Ninag Megha sow

Fig. 2.17. (c). Niang Megha sow with piglets

Fig. 2.17. (d). Niang Megha piglets

Fig. 2.17. (e). Thick bristle of Niang Megha pig

Fig. 2.17. (f). Grower Niang Megha pig

Although natural mating is common under field conditions, some areas are covered by artificial insemination services by state development department and ICAR organization. Artificial insemination is gaining popularity among the farmers. Traditional slaughtering is done in an inhumane and unhygienic manner.

Productive and reproductive performance: The average body weights of Niang Megha pig at birth, weaning and adult age are 0.64±0.02, 4.72±0.11 and 63.38±1.21 kg, respectively. Female pigs are heavier than males both during birth and adult age. The average pre-weaning growth rate is 75 g/day. The overall mean heart girth, punch girth, height at shoulder, height at back, height at foreleg, height at back leg and body length of the adult animal is 103.78±1.66, 106.78±3.82, 49.12±0.54, 51.87±0.53, 30.75±0.26, 33.15±0.28 and 90.15±1.86 cm, respectively.

Average litter size at birth and weaning is 6.50±0.21 and 5.63±0.42, respectively. Average age at first heat and first farrowing is 210.50±2.42 and 355.25±2.25 days, respectively. Inter-farrowing interval is 207.05±8.16 days. Males of this breed attain sexual maturity at very early age. Dressing percentage of the adult animal is 70% with an average back fat thickness of 3.5 cm.

Niang Megha is the second recognized pig breed of India with Accession No: INDIA_PIG_1300_NIANGMEGHA_09002.

Nicobari

Habitat: The breeding tract of this pig is Car Nicobar and adjoining islands (Teressa Island, Katchal Island, Nancowrie Island, Chowra Island, Camorta Island and Little Andaman) of Andaman and Nicobar Islands. This breed is also known as Nout and Ha-Un. The breeding tract extends from 6° to 14° north latitude and 92° to 94° east longitude. The average mean temperature of the area varies from 27° to 30°C with an average annual rainfall of 3,155 mm. The habitat is mostly plain with small hilly areas in few places.

Physical appearance: The pigs are short to medium in size with active look. The colour varies from mostly black to reddish brown, brown, grey and fawn. Sometimes dark reddish-brown stripes are found on the body. Face of this pig varies from flat to concave type. Ears are short, coarse and erect upward. Male animals may have well grown canine teeth giving a look of wild boar. White patches are present in extremities like hoof. Coarse hair with presence of marked bristle crest (mane) on the back of the pig extending from mid head or shoulder to base of the tail is present. Female pigs have 5 to 6 pairs of teats along the mid ventral line (Figs. 2.18 a, b, d).

Management system: Pigs are generally raised in free range and semi-intensive system and sometimes with integrated farming system (Figs. 2.18 c, e). The typical tribal hut (Nicobari hut) is generally made on a height of 2 to 3 meter above the ground and pigs are sheltered on the basement of the hut (Figs. 2.18 g, h). Pigs are fed with locally available feed material *viz.* coconut, rice bran, maize, wheat, coconut, taro (*Colocasia*), tapioca, kitchen waste and poultry offals.

Preference of pigs in exchange of goods and service and as a gift is common. Pigs are not slaughtered for commercial purpose and there is no sale of pork among the tribes. The pigs are commonly slaughtered during festivals and ceremony for family

Fig. 2.18. (a). Nicobari male pig

Fig. 2.18. (b). Nicobari female pig

Fig. 2.18. (c). Nicobari pig at organized farm

Fig. 2.18. (d). Nicobari grower

Fig. 2.18. (e). Adult Nicobari pig at organized farm

Fig. 2.18. (f). Nicobari tribal pig rearers

Fig. 2.18. (g). Housing of pig

Fig. 2.19. (h). Shelter of Nicobari pig in the basement of traditional dwelling place (Nicobari hut)

consumption. During the event of Tsunami in the year 2004, majority of pig population was washed out and the escaped domesticated pigs became semi-wild in nature. Pigs are mated by natural mating.

Productive and reproductive performance: The average body weight of adult pigs (above eight months of age) is 63.67±18.18 and 67.33±17.01 kg in males and females, respectively. The body height, length and chest girth is 56.51±2.44, 84.88±4.08 and 84.45±3.01 cm, respectively in adult males and 60.65±2.68, 78.56±2.77, 93.77±3.87, respectively in adult females. Age at first farrowing is 10.91±0.85 months. The litter size at birth is 6.48±0.31. Pigs are slaughtered by cardiac puncture. Average age at slaughter is 12.76±1.07 months. Dressing percentage varies from 70 to 75%.

Nicobari pig is the fifth recognized pig breed of India (Accession No: INDIA_PIG_3300_ NICOBARI _09005).

Fig. 2.20. (a). Adult Pondi pig

Fig. 2.20. (b). Pondi pig in scavenging system

Pondi

Habitat: These pigs are found in parts of Ganjam district of Odisha and neighbouring plains of Andhra Pradesh. The breed is mainly reared by Koraput tribes and known as Pongi or Jhinga pigs. They are also popular in peri-urban areas of Rayagada. The latitude and longitude of the breeding tract is 19° to 20°172 north and 84°92 to 85°12 east. The average annual rainfall is 1,444 mm, experienced as the result of south-west monsoon during June to September. The average temperature varies between 15° and 35° C.

Physical appearance: This breed is also known as Jhinga by the local people. The pigs are mostly black. They are fatty in appearance with long twisted tail (Fig. 2.20 a).

Management system: The pigs are raised by scavenging and grazing system (Fig. 2.20 b). They move in flocks and walk fast. Supplementation of grain, rice bran and kitchen waste is also common.

Productive and reproductive performance: They are medium in size and attain up to 50 kg body weight in adulthood. Animals of this breed are prolific with average litter size ranging from 6 to 9.

Purnia Desi

Habitat: This breed is predominant in Purnia and Araria districts of Bihar but is also found in other parts of Bihar and some parts of Jharkhand. The breeding tract lies in the sub-mountain alluvial tract of the Gangetic plain. The breeding tract extends from 24° to 27° north latitudes and 83° to 88° east longitudes. The average mean temperature of the area varies from 20° to 25°C with an average annual rainfall of 1,600 mm. The tribal communities of this area mostly rear these pigs.

Physical appearance: They are of medium size, black, with round shape face, and small and erect ears. Animals have thin but strong bristles developed over the backline (Fig. 2.21 a, b).

Management system: Animals are mainly reared in backyard system of management.

Productive and reproductive performance: The average litter size at birth and weaning are 6 and 5, respectively. The litter weight at birth and weaning are 4.18 and 28 kg, respectively. The average body weight at birth and adult age are 0.6 and 31 kg, respectively.

Sows of this breed formed the foundation stock of the popular crossbred variety "T&D" (Tamworth and Desi) which is found in Bihar and Jharkhand state.

Fig. 2.21. (a). Purnia desi grower pig

Fig. 2.21. (b). Purnia desi adult female

Tenyi Vo

Habitat: The breeding tract of this pig is in Nagaland and adjoining areas. The breed is also known as Naga Local and Suho. They are mostly found in districts of Kohima, Dimapur, Peren and Phek districts of Nagaland and Senapati district of Manipur. The breeding tract is mostly mountainous except those areas bordering Asom valley. It lies between the parallels of 98° and 96° east longitude and 26°62 and 27°42 north latitude. Annual rainfall averages around 1,800 to 2,500 mm, precipitated during May to September. Temperature ranges from 21° to 40°C. In winter, temperatures do not generally drop below 4°C, but frost is common at high elevations. The breeding tract enjoys a salubrious climate.

The Tenyi Vo pigs have a history of domestication since last 500 to 600 years. Although these pigs are reared by almost all the tribes of Nagaland, but it is very popular among Chakesang, Rengma, Zeliang, Mao and the Angami tribes and known by different names viz. Votho (Angami and Chakesang), Nziena Bak (Zealiang), Anyüjoba/Amivü (Rengma).

Physical appearance: Animals are small in size, generally black, light brown and light black with white spot/stripe in under belly, neck region, lower jaw and leg area. Hair is sparsely distributed over the body. Coarse bristles extend from the withers to the hind-quarters. They have small ears which are upward and inwardly placed. The face is long, tapering towards the strong and long snout. Animals are pot-bellied in appearance with a strong body. The tail almost touches the hock joint and ends with a white switch. Adult female pigs have a sagging back and pendulous belly almost

reaching the ground. They have good mothering ability and become aggressive during farrowing (Figs. 2.22 a, b, c).

Management system: The pigs are semi-wild type. They are raised on scavenging and backyard system (Figs. 2.22 d, g). They feed on vegetables and kitchen waste other than scavenging. Supplementation with concentrate is not common. The local pigs are housed in small enclosures made with locally available material with *kaccha* flooring (Fig. 2.22 f). In most of the rural areas, indigenous pigs are usually raised in open space freely and are allowed to roam in the vicinity of villages and left to find their own food. Piglets are usually let loose with their suckling mother in the open for scavenging and suckling. Inbreeding is on the rise due to increased incidences of mating between relatives. Natural breeding is the sole mating practice in the rural areas.

Productive and reproductive performance: The average body weight of this pig at birth, weaning and adult age is 325.16±5.87 g, 5.48±0.17 kg and 17.15±0.19 kg, respectively. Male pigs have higher body weight at birth and adult age than the females.

The overall mean body length is 11.85±0.50, 25.46±0.48 and 55.63±0.25 cm, respectively, at birth, weaning and adult age. The mean heart girth at birth, weaning and adult age is 12.81±0.10, 20.75±0.30 and 64.91±0.43 cm, respectively. The overall mean height at wither is 12.71±0.10, 16.31±0.17 and 28.44±0.18 cm, respectively, at birth, weaning and adult age.

The mean age at first fertile service and age at first farrowing is 182.30±2.04 and 298.35±2.03 days, respectively. The mean gestation length and farrowing interval is 116.06±0.19 and 149.99±2.36 days, respectively. The litter size at birth and weaning are 6.28±0.37 and 5.20±0.33. Litter weight at birth and weaning are 1.91±1.92 and 25.60±2.54 kg, respectively. Animals of this breed exhibit early sexual maturity. As reported by the farmers, male piglets impregnate mother sows before castration. Castration is usually done by open method following indigenous traditional knowledge between 90 to 105 days of age.

Tenyi Vo pig is the fourth recognized pig breed of India with Accession No: INDIA_PIG_1400_ TENYIVO _09004.

Fig. 2.22. (a). Adult Tenyi Vo female

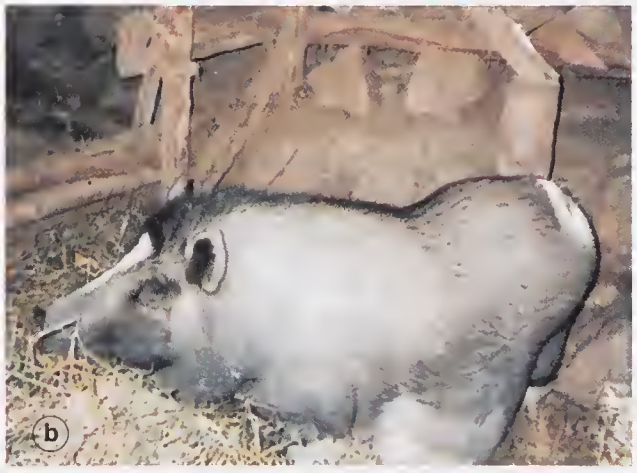

Fig. 2.22. (b). Tenyi Vo preparing her nest for farrowing

Fig. 2.22. (c). Tenyi Vo sow with litter

Fig. 2.22. (d). Tenyi Vo sow in semi-intensive sytem

Fig. 2.22. (e). Grower Tenyi Vo pig

Fig. 2.22. (f). Housing for Tenyi Vo pigs

Fig. 2.22. (g). Tenyi Vo pigs in scavenging system

Zovawk

Habitat: The breed is also known as Mizoram Local. The breeding tract of this pig is in Mizoram and adjoining areas. The breeding tract is mountaineous in nature. The latitude and longitude of the breeding tract is 22° to 24°52 north and 92°52 to 93°52 east. Mizoram has a mild climate, comfortable in summer (20° to 29°C) and pleasant in winter (7° to 21°C). The region is influenced by monsoons, raining heavily from May to September with little rain in the dry (cold) season. The average annual rainfall is 2540 mm. The local Mizo tribes are the rearers of this pig.

Physical appearance: They are of smaller size and predominantly black. Occasionally white patches on forehead, belly and leg are also found. Adult females are pot-bellied sometimes touching the ground line. Face line is concave and protruding forward. Resilient strong rough bristles around the neck are found in male which is less predominant in female (Fig. 2.23 a-g).

Management systems: These pigs are mainly raised in backyard and semi-intensive system (Fig. 2.23 i). Locally available feed resources and plants viz. Vawkpuithal (*Bidens biternata*), Khup Nal (*Hibiscus sp.*), Ankasa (*Spilanthes sp.*), Japan Hol (*Mikenia scanden*),

Fig. 2.23. (a). Breeder Zovawk male

Fig. 2.23. (b). Zovawk growers

Fig. 2.23. (c). Zovawk piglets with sow

Fig. 2.23. (d). Pregnant Zovawk sows

Fig. 2.23. (e). Lactating Zovawk sow

Fig. 2.23. (f). Zovawk weaned piglets

Fig. 2.23. (g). Zovawk pig under field conditions

Collocassia (*Colocasia esculenta*) and banana pseudostem (*Musa paradisiaca*) along with kitchen waste are the major feed ingredients for these animals. The ingredients are boiled before offering them to animals. Housing is made by locally available bamboo or wooden planks.

Productive and reproductive performance: At birth and weaning, the average litter size is 6.28±0.64 and 5.57±0.81; and average body weight 0.55±0.03 and 4.24±0.43 kg, respectively. The male animals are usually heavier than females. Pre- and post-weaning growth rate is 87.85 and 127.56 g/day, respectively. The 8 month and adult (12 month) body weights are 23.79 and 35.5 kg, respectively. Dressing percentage is 70.14% with an average back fat thickness of 2.27 cm.

The overall mean body length is 16.78±1.14, 35.41±0.70 and 73.55±1.02 cm, respectively, at birth, weaning and adult age. The mean heart girth at birth and weaning are 15.58±0.77 and 32.09±0.75 cm, respectively. The average height at wither is 15.03±0.15 and 26.61±0.54 cm, respectively, at birth and weaning.

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3

Evaluation and Characterization of Indigenous Pig Genetic Resources

The animal genetic resources (AnGR), as defined by FAO, refer to those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each species. The populations within each species can be classified as wild and feral populations, landraces and primary populations, standardized breeds, selected lines, varieties, strains and any conserved genetic material - all of which are currently categorized as breeds. The present global scenario of World Trade Organisation (WTO) and Intellectual Property Rights needs protecting the local animal genetic diversity as per Convention on Biological Diversity (CBD) and to provide recognition to the developers of new improved animal breeds as per Trade-Related Aspects of Intellectual Property Rights (TRIPS) (Guidelines for breed registration, ICAR-NBAGR).

The indigenous pigs of India are identified as a distinct group as a result of gradual domestication of wild pigs in different geographical isolation. These pigs differ in their characteristics and attributes from region to region depending on its breeding tract. Registration of animal germplasm has been initiated at the ICAR-National Bureau of Animal Genetic Resources (NBAGR) to form the national databases of different livestock and poultry species including pig. Any unique breed/population/strain of domesticated pig and their wild relatives, which is stable and uniform, and has potential attributes of academic, scientific or commercial value can be registered under national database by any citizen of India or registered breed society or NGO or any other Government agency by proper application available at the website of ICAR-NBAGR.

Phenotypic characterization

As per FAO, phenotypic characterization of animal genetic resources for food and agriculture is the practice of systematically documenting the observed characteristics, geographical distribution, production environments and uses of these resources. This process involves identification and description of characteristics of distinct breed population in its breeding tract or habitat. It also includes natural management practice, common use and market orientation of the germplasm. Primary characterization requires field survey to collect the primary data by direct interaction, and advanced characterization is done by deriving secondary data, viz. productivity, adaptability etc. For characterization of pig genetic resources, general information about the household, feeding and housing management practices, physical and qualitative traits including growth, reproduction and carcass characters are collected (see Chapter 2). A comprehensive

list of quantitative and qualitative traits for characterization of pig genetic resources is given Annexure III.

Molecular genetic characterization

The study of genetic variation reveals information about population structure, migration, bottleneck, localization of important genes and selection in the population. The genetic variation may be studied at different levels, e.g. chromosomal variation (karyotype), immunological variation (e.g. blood group), protein variation (e.g. enzyme) or the variation in nucleic acid level (DNA and RNA). The polymorphism at molecular level could be because of transition, transversion, insertion or deletion (indel) or variation in the number of tandem sequence repeats like minisatellite and microsatellite. The different measures of polymorphism at individual or population level are number of polymorphic loci, observed heterozygosity (Ho), expected heterozygosity (He), allelic diversity (A), mean number of alleles (MNA) etc.

The markers for molecular variation could be randomly amplified polymorphic DNA (RAPD), restriction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP), PCR-RFLP, minisatellite, microsatellite, mitochondrial DNA (mtDNA), Y chromosome or single nucleotide polymorphism (SNP). The most widely used among these are microsatellite, mitochondrial DNA (mtDNA) and single nucleotide polymorphism (SNP). Microsatellites are tandem repeats of short nucleotide sequences characterized by difference in number of repeats. Two main mutation models, namely infinite allele model (IAM) and step-wise mutation model (SMM) have been associated with mutation at microsatellite loci. The microsatellites are developed either by using and screening of DNA repositories sequences or through cloning. The microsatellites loci are also known as STR, SSR, VNTR.

The microsatellites have varied application in the field of population genetic studies, conservation, disease diagnostics and forensics. The main advantages of microsatellites are high genomic abundance, random distribution, high degree of polymorphism, co-dominance and high reproducibility.

Molecular data have become more and more relevant for characterization of genetic diversity since the beginning of the 1990s (Groeneveld *et al.* 2010). A global programme for characterization of AnGR, including molecular genetic characterization and the secondary guidelines for measurement of domestic animal diversity (MoDAD) was proposed by FAO in 1993. This set up the impetus for the growth of the study of genetic diversity of livestock at molecular level into a most active area of research. These studies resulted in identification of wild ancestors of livestock species and localization of the site(s) of domestication, provided insight into the breed formation, assessed the genetic constitution of breeds, partially reconstructed the phylogenetic relationships of populations unravelling the evolutionary history, investigated algorithms that can be used to prioritize breeds for conservation, introduced these data into the permanent scientific records, provided the opportunity to publicize the issues surrounding loss of livestock diversity, and established an informal international network of organizations and institutions interested in molecular studies of AnGR (FAO, 2011). These fields were further revolutionized by the availability of dense marker panels of SNPs for most of

the livestock species. International Porcine SNP Chip Consortium developed SNP chips of more than 64,000 SNPs uniformly spanned over porcine genome.

Refer to FAO (2011) for guidelines for carrying out molecular diversity studies in livestock species.

Groeneveld *et al.* (2010) analysed highly polymorphic microsatellite markers. The FAO and the ISAG–FAO Advisory Group on Animal Genetic Diversity proposed panels of 30 microsatellite markers for nine major livestock species (FAO 2011).

Present status of characterization of pig genetic resources of India

Phenotypic characterization and breed registration: Phenotypic characterization of indigenous germplasm was initiated in different pockets of the country by AICRP centers, State Agricultural Universities, Central Agricultural Universities, different NGOs and State departments. Ghungroo, Niang Megha, Agonda Goan, Nicobari, Tenyi Vo and Doom have been registered as breed in national database. Few more genetic resources have also been characterized and registration of these varieties as breed is under process.

Molecular genetic characterization: Investigation of polymorphism of 13 microsatellites in North Indian (NR) and Northeast Indian (NE) by Kaul *et al.* (2001), revealed that number of alleles at a locus varied between 5 and 12. The microsatellites exhibited a very high heterozygosity and polymorphism information content (PIC). The probability of identity of two random individuals from different populations was as low as 3.51×10^{-19} taking into account all the 13 microsatellites. Genetic identity of these two Indian pig types was also analyzed by Behl *et al.* (2002). The total number of alleles ranged between 4 (S0178 in NE) and 12 (S0355 in NR) with little difference between the breeds. The effective number of alleles ranged from 2.8 (S0178) to 7.9 (S0005) in NR and from 2.5 (S0178) to 8.7 (CGA) in NE. The mean effective number of alleles for all 23 loci was 5.0 in NR and 5.3 in NE. It was also reflected in mean observed heterozygosities of 0.71±0.14 and 0.68±0.12 in NR and NE, respectively. The mean effective number of alleles and the mean observed heterozygosity were quite similar in both pig types, and observed heterozygosity values in Indian pig populations were a little higher than European breeds. It might be due to large effective population in Indian pig types. Nei's original measure of genetic distance and Nei's unbiased measure of genetic distance between these two populations were 0.196 and 0.160, respectively, revealing close genetic identity of NR and NE pig types in contrast to earlier suggestions of separateness.

Ankamali pigs, were genetically characterized using 23 FAO recommended microsatellite markers and compared with other native Indian pigs (Behl *et al.*, 2006). The allele size varied between 92-108 bp at locus S0026 and 280-296 bp at locus IGF-1. The total number of alleles varied between 5 (S0178 and S0386) and 11 (S0355). The mean observed and expected heterozygosities were 0.74±0.09 and 0.83±0.03, respectively. The Ankamali pigs did not show genetic closeness with other native Indian pig types with high bootstrap values indicating genetic distinctness.

Andaman Desi pigs of Andaman and Nicobar islands, were genetically characterized using 23 FAO recommended microsatellite markers (De *et al.* 2013). The allele size varied between 86 and 116 bp at locus SW936 to 280 and 296 bp at locus IGFI. The total number of alleles ranged between 5 (S0228, SW122, SW951, SW24 and S0178) and 12 (S0355).

The effective number of alleles (Ae) ranged between 3.14 (SW24) and 8.1 (S0355). The mean PIC for all the 23 studied loci revealed high genetic diversity.

Molecular characterization of Ghungroo of West Bengal, using 21 microsatellite markers (Zaman *et al.*, 2013a) revealed that loci were highly polymorphic. The range of alleles varied between 2 and 9. The frequency distribution of microsatellite alleles was between 0.0179 and 0.9615 in the population. The observed and expected heterozygosity values were 0.55±0.356 and 0.58±0.216, respectively. The PIC was 0.54±0.22 and Shannon's information index (I) was reasonably high with a mean value of 1.16. The overall mean of within-population inbreeding estimate (F) was 0.0919. The bottleneck analysis revealed that population has not undergone any recent reduction. Sahoo *et al.* (2015) characterized Ghungroo pigs using 22 FAO-ISAG microsatellite markers. The average number of observed allele and effective average number of allele were 8.18±0.62 and 4.39±0.26. The observed heterozygosity ranged between 0.4 and 0.96 and the expected heterozygosity between 0.55 and 0.85. The PIC ranged between 0.55 and 0.85. No genetic bottleneck was observed in the studied population. The group reported 45 private alleles, which may be used as breed - specific markers.

Genetic diversity analysis of Mali pigs of Tripura using 19 microsatellite markers (Zaman *et al.* 2013b) revealed that number of alleles (Na) varied between 3 and 11. The effective number of alleles (Ne) ranged between 1.172 and 6.502. The PIC value ranged between 0.141 and 0.794. The average observed (Ho) and expected (He) heterozygosities were 0.38±0.052 and 0.57±0.059, respectively. The within breed inbreeding estimate indicated towards heterozygosity shortage (0.290). The bottleneck analysis revealed that population has not undergone any recent reduction.

Molecular characterization of Meghalaya Local pigs (Niang Megha) using FAO recommended 21 microsatellite markers (Zaman *et al.* 2013c) revealed less genetic diversity. The observed number of alleles (Na) varied between 2 and 6. The effective number of alleles (Ne) ranged from 1.145 to 4.2169. The PIC ranged between 0.1227 and 0.7281. The observed (Ho) and expected (He) heterozygosities were 0.545±0.279 and 0.548±0.179, respectively. Bottleneck analysis did not reveal any recent reduction. Sahoo *et al.* (2016a) analyzed genetic variation in Niang Megha pigs using 22 FAO-ISAG microsatellite markers. Average number of observed alleles and effective average number of alleles were 6.95±0.54 and 3.55±0.33, respectively. The mean observed heterozygosity was 0.61±0.04, and expected value 0.67±0.03. The PIC value ranged between 0.41 (Sw2008) and 0.86 (S0218). No genetic bottleneck was observed in the studied population, and a total of 23 private alleles were observed in Niang Megha pigs.

Nagaland local pig (Tenyi Vo) was genetically characterized using FAO recommended 22 microsatellite markers (Zaman *et al.* 2013d). The number of observed alleles (Na) varied between 3 and 11. The mean effective number of alleles (Ne) was 3.66±1.229. The PIC value ranged between 0.3448 (S0225) and 0.8175 (SW353). The observed (Ho) and expected (He) heterozygosities were 0.62±0.224 and 0.69±0.116, respectively. No population bottleneck was reported. Sahoo *et al.* (2016a) analyzed genetic variation in these pigs using 22 FAO-ISAG microsatellite markers. Average number of observed alleles and effective average number of alleles were 7.18±0.45 and 3.81±0.41, respectively. The mean observed heterozygosity was 0.68±0.05, whereas expected value was 0.69±0.03. The PIC value ranged between 0.45 and 0.88. No genetic

bottleneck was observed in the studied population, and 22 private alleles were observed in Nagaland local pigs.

Genetic diversity analysis of Doom pigs carried out using FAO recommended 22 microsatellite markers (Zaman *et al.*, 2014), revealed 120 alleles across the loci. The allele range varied between 4 and 10 with an average of 5.40±1.65. The observed and expected heterozygosity values were 0.62±0.287 and 0.67±0.142, respectively. The PIC value was 0.63±0.143. Moderate to less genetic diversity was reported in the studied Doom population. The bottleneck analysis did not reveal any recent reduction in the population.

Sahoo *et al.* (2016b) assessed genetic diversity and evolutionary relationships of Ghungroo, Niang Megha and Nagaland Local pigs by genotyping with a panel of 22 ISAG-recommended microsatellite loci and sequencing partial 12S rRNA (MTRNR1) gene. The mean number of alleles per locus, effective number of alleles and observed heterozygosity were 11.27±0.85, 5.29±0.34, and 0.795±0.01, respectively. Moderate F_{ST} value (0.115±0.01) indicated a fair degree of genetic differentiation among the native breeds. The mean observed heterozygosities for the native breeds were 0.71±0.04, 0.61±0.04 and 0.68±0.05, with their expected values as 0.75±0.02, 0.67±0.02 and 0.69±0.03 for Ghungroo, Niang Megha and Tenyi Vo pigs, respectively. The overall PIC was more for these markers in Ghungroo breed. The mean observed and expected numbers of alleles for the native breeds were 8.18±0.62, 6.95±0.54 and 7.18±0.45, and 4.39±0.26, 3.55±0.33 and 3.81±0.41 for Ghungroo, Niang Megha and Tenyi Vo pigs, respectively. Lesser genetic distance (0.2909) between Niang Megha and Tenyi Vo pigs than the both individually with Ghungroo breed was indicated based on Nei's unbiased genetic identity estimates. The estimated divergence time between Ghungroo and Tenyi Vo was about double than that of Niang Megha and Tenyi Vo pigs. The approximate divergence time was calculated to be 6,589 years between Ghungroo and Niang Megha and 6,681 years between Ghungroo and Tenyi Vo pigs. Analysis of MTRNR1 gene revealed distinct clustering of native Indian pigs with Chinese pigs over European pigs. The study revealed abundance of genetic variation within native Indian pig populations and their relationships as well as genetic distances.

Saikia *et al.* (2015) investigated genetic variability in Cytochrome B gene of mitochondrial DNA for deciphering evolutionary relationship among Ghungroo, Niang Megha and Nagaland local. Four SNPs at position 47(C), 49(A), 52(T) and 56(A) that corresponds to 15036, 15038, 15041 and 15045 nucleotide positions of mitochondrial genome were detected. This particular combination of SNPs indicated Asiatic origin of indigenous pigs further pointing to A1 haplotype.

Sufficient genetic variation exists within different breed/types of indigenous pigs. Unlike pig breeds of developed countries that are well-defined and has undergone high selection pressure, almost absence of selection pressure in Indian scenario has been responsible for maintaining high genetic diversity. Considering high variability in production performances in indigenous pigs, it offers large untapped opportunities that may be harnessed using traditional and molecular breeding.

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SECTION-II
Genetic Improvement Programmes

4

Exotic Pig Breeds Used in India

OWING to poor performance of indigenous pig germplasm and for further upscaling of piggery sector in India, All India Coordinated Research Project (AICRP) on Pig recommended region-specific crossbreeding program for improvement of economic traits of native pigs in the beginning of Sixth Five Year Plan. Further National Commission on Agriculture (NCA) in 1976 stressed on the import of exotic pigs for development of piggery sector in India. It was felt that upgradation up of the indigenous pigs using males of superior exotic breeds would provide the necessary impetus for overall development of the sector. Additionally, the exotic stocks were supposed to be extensively used by artificial insemination for faster multiplication of superior germplasm. Prior to recommendation of NCA (1976), limited numbers of pigs were imported from countries like USA, Australia and Ireland (Table 4.1).

Table 4.1. Import of exotic pigs in India after NCA recommendation

Year	1977		1979		1989		2000	
Breed	Male	Female	Male	Female	Male	Female	Male	Female
Large White Yorkshire	52	112	44	108	62	137	54	72
Landrace	29	63	4	1	8	10	14	13
Hampshire	22	61	41	183	6	15	48	79
Saddleback			3	6	10	5		
Berkshire					5	4		
Total	103	236	92	298	91	171	116	164

(*Source:* Piggery India Year Book. *Second Edition. Scientific Publishers & Distributors, Delhi, India.)*

Later a centrally sponsored scheme namely "Assistance to States for Integrated Piggery Development" was started during 1991-92 to strengthen State Government Pig Breeding Farms including import of exotic germplasm to India. Mizoram and other states subsequently imported exotic pigs. The scheme started in 1991-92, and 87 pigs were imported for Mizoram during 1997-98.

In recent times, frozen semen of Large White Yorkshire breed has been imported from Canada by different organizations in Punjab and Mizoram.

Limited information on performance of exotic pigs and their use in piggery development programme is available. Exotic breeds, viz. Berkshire, Burmese, Charmukha, Duroc, Hampshire, Landrace, Large Black, Large White Yorkshire, Middle

White Yorkshire, Tamworth, and Wessex Saddleback, were imported to India for piggery developmental programme.

Berkshire: The Berkshire, one of the oldest English breed of swine, is a black pig specifically preferred for pork quality. Animals have disc shaped face with six prominent white spots in four extremities of legs, face and tip of tail. Mature boars and sows weigh about 280 to 360 kg and 204 to 294 kg, respectively. Berkshire pigs were imported to India in 1989.

Burmese: These are small black pigs, also found in Manipur and neighbouring states of India that share international boundary with Myanmar. This breed is moderately prolific and found to be exclusively used for breeding with local pigs of Manipur and Nagaland. Animals of this breed have not been officially imported, but may have found their route through porous border as these are popular choice for local pig rearers.

Charmukha: This breed was imported in north eastern and eastern states of India from Russia for upgradation of local pigs. These pigs are spotted with patches of black and white marking. The animals are heavy with strong head and shoulders. Face is slightly dished with long extending ears. The animals have short and stout legs with strait or slightly arched back (Figs. 4.1 a, b). Bristles are long and straight. Few animals of this breed are still available in some parts of Jharkhand.

Duroc: Duroc, from USA, is reddish brown, with the shades varying from golden to very dark red. The weight of mature boar and sow is about 400 kg and 250 kg, respectively. Their ears droop forward over the eyes. Duroc has a medium body length and slightly dished face. It has a large-framed body. The forequarters, particularly the head and neck, are light weight (Figs. 4.2 a, b) . Duroc is late-maturing type and excellent for heavy-carcass production.

Duroc sires are utilized most frequently as a terminal sire in a crossbreeding programme for lean meat production. The offspring excels in durability, growth, and muscle quality attributes and is competitive with other industry sires for carcass leanness and feed efficiency.

Hampshire: This breed was developed in Kentucky of USA from hogs imported from UK. It is a black hog with a white belt encircling the body which may include front legs. The weight of a mature boar and sow is about 300 kg and 280 kg, respectively.

The breed is used extensively as the sire of crossbred pigs for the pork and manufacturing markets in the USA and many other countries. The breed is leanest of the North American pig breeds. The breed has immense contribution towards development of crossbred lines for commercial pig production in world scenario as the best terminal sire breed for all purposes.

Head and tail are black (Figs. 4.3 a, b) . Animals of this breed are good for breeding with high energy, hardiness and vigour. Hampshire is said to be an easy-care pig for beginners and an efficient feeder and forager. Animals of this breed were imported to India on several occasions and subsequently used in crossbreeding programme.

Landrace: Landrace pig is an excellent bacon yielder with large barrel shaped body (Figs. 4.4 a, b). It is a native of Denmark. It was imported into Britain in 1949 and is the second popular breed in UK. The breed was imported to India after 1977 for crossbreeding

experimentation. The pigs proved to be superior to Large White Yorkshire in carcass quality. Boars of 25 weeks of age weigh about 95 kg. Sows of this breed have good mothering ability and produces comparatively higher amount of milk to nourish its litter than sows of other exotic breeds.

Large Black: Large Black originated from the Old English Hog used for its foraging abilities and its maternal qualities in different crossbreeding programs.

The breed is large framed, solid black, hardy and docile. The pig has a long and deep body. The black skin makes the breed very good at coping with sunburn and a popular choice in hot climate (Figs. 4.5 a, b). They are very docile. Despite the breed's size, handling is not a problem and hence, it is ideally suited for all kinds of management systems. This breed was used in crossbreeding programme in different parts of north eastern states of India, however, availability of pure Large Black animals is now rare at organized farm and farmers' field.

Large White Yorkshire: The Large White Yorkshire is a native breed of Yorkshire county of England and is reported to produce better bacon when crossed with other suitable types. Animals of this breed were imported to India from UK, New Zealand and Australia. Mature boars and sows of this breed generally weigh 295 to 408 kg and 227 to 317 kg, respectively. This breed is very popular for bacon. They and their descendants, the Yorkshire, are found in practically all crossbreeding and rotational breeding programmes involving two or more breeds. Modern breeding programmes have developed separate sire and dam lines to produce purebred Large White terminal sires that excel in growth rate and lean meat percentage and are incorporated in terminal sire breeding programmes.

The Large White Yorkshire has proved itself as a rugged and hardy breed that can withstand wide range of climatic conditions and other environmental factors. Their ability to cross with and improve other breeds has given them a leading role in commercial pig production systems and breeding pyramids around the world.

Large White Yorkshire breed is distinguished by their erect ears and slightly dished faces. They are long-bodied with fine white hair and, as their name suggests, they are characterized by large size. Skin is pink and free from wrinkles. Neck is long and full to the shoulders with deep and wide chest. They are late maturing type. Legs are longer than other breed and tend to have poor ham development (Figs. 4.6 a, b).

Middle White Yorkshire: The Middle White Yorkshire was evolved as a result of crossing of Large White Yorkshire and Small White Yorkshire breeds of Northern England of UK. It is a medium sized bacon breed. Mature boars and sows of this breed generally weigh 249 to 340 kg and 181 to 272 kg, respectively.

These are medium size white pigs with characteristic snub nose, short head and large prick ears. The breed has a stocky build and is more compact than many other pig breeds. The Middle White Yorkshire pigs are hardy and fairly good feeder. It is a good grazing animal and is suitable for extensive system of rearing. It is comparatively early maturing type than Large White Yorkshire.

Tamworth: Tamworth is modern representative of the native English pig. The colour is reddish or chestnut with typically golden red hair on a flesh coloured skin.

The skin is flesh colour and free from coarseness, wrinkles and black spots. Tamworth pigs have a straight face and long snout, narrow head and a long, narrow body. They have erect ear and long legs (Figs. 4.7 a, b). It is very hardy and docile breed and pigs can be kept in varying climatic conditions. The breed is very active. Mature boars weigh up to 300 kg.

Wessex Saddleback: Wessex Saddleback is an English breed used for bacon purpose. The breed is easily adaptable. They are highly prolific with a robust make-up. Animals of this breed are black with large, long head and straight snout. The ears hang forward and slightly downward but do not cover the face. Pigs of 8 weeks of age weigh 21.5 kg on average. Mature animals weigh up to 350 kg. Few animals of this breed were imported to India in 1979 and 1989.

Performance of exotic pig breeds in India

In order to upgrade the native stock for superior performance, exotic pig germplasm have been imported time to time from countries like USA, UK, New Zealand and Australia. These animals were made to adapt the prevailing production system of India and their performance (Table 4.2) was evaluated by different AICRP centers.

From crossbreeding experimentation of All India Coordinated Research Project on Pig and other piggery development programmes, Hampshire was recommended for north and north-eastern part, while Large White Yorkshire for southern and central part and Tamworth in central and eastern part of India.

Table 4.2. Performance of exotic breeds at different AICRP centers

Trait	Large White Yorkshire		Landrace	
	Jabalpur	Tirupati	Izatnagar	Khanapara
Litter size at birth (no.)	8.96	8.38	8.31	8.16
Litter size at weaning (no.)	8.26	8.16	7.60	7.52
Litter weight at birth (kg)	11.33	10.60	11.50	10.20
Litter weight at weaning (kg)	95.11	92.43	82.49	80.98
Birth weight (M) (kg)	1.28	1.28	1.37	1.27
Birth weight (F) (kg)	1.25	1.25	1.35	1.23
Weaning weight (M) (kg)	11.62	11.31	11.87	11.10
Weaning weight (F) (kg)	11.41	11.41	10.89	11.08
Weight at 32nd week (M) (kg)	74.90	72.36	64.14	66.00
Weight at 32nd week (F) (kg)	70.11	68.33	68.17	62.48
Weight at slaughter (kg)	79.56	74.73	74.10	85.93
Dressing *percentage* (%)	71.44	79.03	74.45	61.49
Backfat thickness (cm)	2.60	2.70	2.24	2.26
Feed efficiency (feed: weight)	3.90	3.82	4.31	4.40

(*Source*: Review Committee (QRT) Report on All India Coordinated Research Project on Pig (1992-97). Indian Council of Agricultural Research, Pusa, New Delhi. India.)

Fig. 4.1. (a). Charmukha boar; **(b).** Charmukha sow

Fig. 4.2. (a). Duroc boar; **(b).** Duroc sow

Fig. 4.3. (a). Hampshire boar; **(b).** Hampshire sow

Fig. 4.4. (a). Landrace boar; **(b).** Landrace sow

Fig. 4.5. (a). Large Black boar; **(b).** Large Black sow

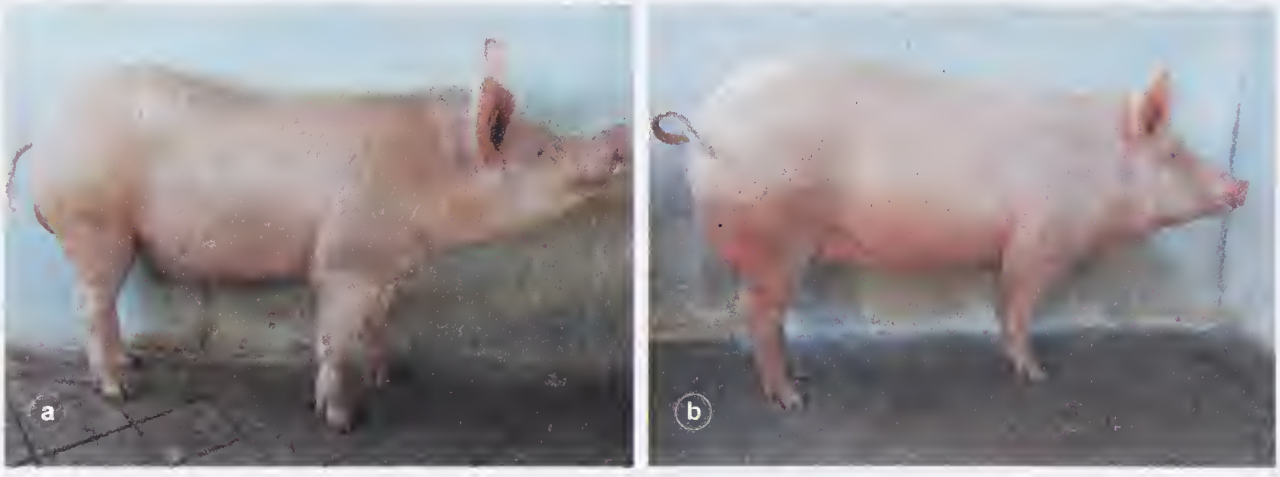

Fig. 4.6. (a). Large White Yorkshire boar; **(b).** Large White Yorkshire sow

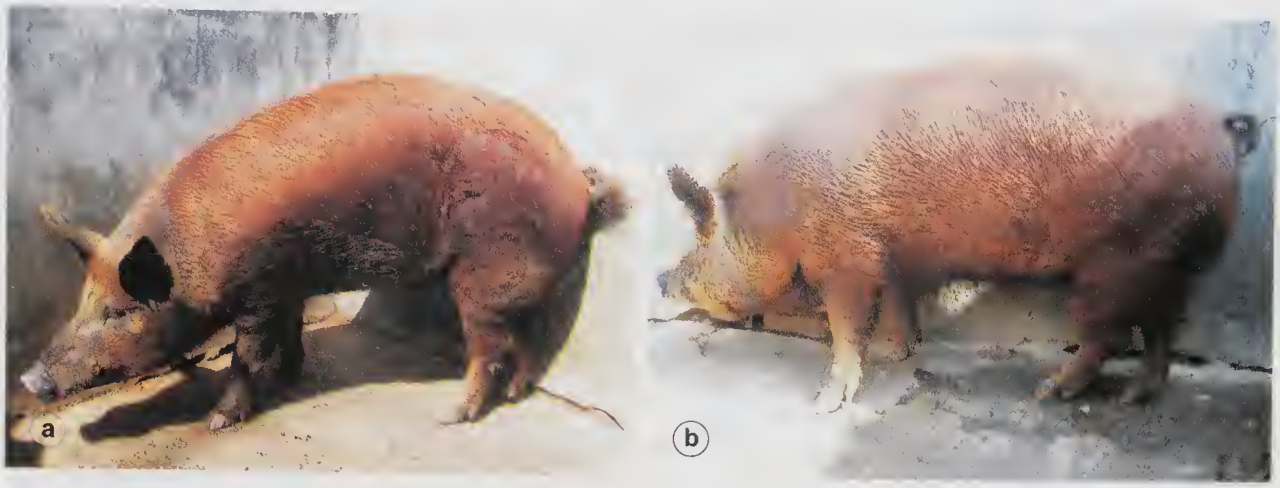

Fig. 4.7. (a). Tamworth boar; **(b).** Tamworth sow

5

Piggery Development Programmes in India

Not much is known about the piggery development in India before independence except sporadic import of few superior pig germplasm by the missionaries for rural development in few pockets of India. However, no systemic efforts were made till independence for development of this sector. Chronological developments in the sector since independence are given below.

Plan period-wise development

In First Five Year Plan (1951-1956), little attention was given to piggery development in the country. In Second Five Year Plan (1956-1961), for the first time, Coordinated Piggery Development Programme was launched in 1959-60 for development of piggery. Two regional pig breeding stations, two bacon factories and 15 pig breeding units/farms and 33 piggery development blocks were established under this programme. In Third Five Year Plan (1961-1966), more number of regional pig breeding stations, pig breeding units/farms, piggery development blocks and bacon factories were established. Selective breeding for distribution to pig breeding farms/units in rural areas for further multiplication was the main objective of Regional Pig Breeding Stations.

Major leap in pig population was observed during Fourth Five Year Plan (1969-1974). During this period, Indian Council of Agricultural Research (ICAR) started All India Coordinated Research Project (AICRP) on Pig (1970) with the objective of studying the performance of purebred native germplasm of India under existing management conditions.

In Fifth Five Year Plan (1974-1979), urgent need for genetic improvement of indigenous pig was realized in view of their large number and high socio-economic importance to the rural population. Efforts were made to develop types of pig suitable for both intensive and diversified farming system including backyard system of rearing with optimal feed conversion efficiency. The technical programme of AICRP on Pig was completely remodeled to undertake research; first on indigenous pig and then subsequently on the crossbreeding between indigenous pig with appropriate exotic breed with the objective of evaluation of the performance of different breeds and breed combinations under different agro-climatic condition prevailing in the country and a multi-disciplinary approach was introduced in the technical programme. Exotic Breeds like Large White Yorkshire, Middle White Yorkshire, Landrace, Tamworth, Saddleback and Hampshire were maintained at Government Pig Breeding Farms with the objective of further genetic improvement of the stock and distribution of improved piglets to farmers for rearing.

In the Sixth and Seventh Five Year Plan (1980-1985 and 1985-1990), superior quality of exotic and crossbred pigs were produced in Government Pig Breeding farms in the country. Improved quality of piglets were distributed to the farmers either for establishment of finisher unit or small breeding units.

Department of Animal Husbandry & Dairying, Government of India, started the centrally sponsored scheme namely "Assistance to States for Integrated Piggery Development" in Annual Plan (1991-92), to strengthen existing pig breeding farms and to establish new pig breeding farms at Krishi Vigyan Kendra, Veterinary College and State Departments.

In Eighth and Ninth Five Year Plans (1992-1997 and 1997-2002), emphasis was given to strengthen the previous scheme "Assistance to States for Integrated Piggery Development" for establishment of more units throughout the country.

In Tenth Five Year Plan (2002-2007) considering the growing importance of piggery sector in the country, National Research Centre on Pig was established at Guwahati, Asom after reviewing the work of the All India Coordinated Research Project (AICRP) on Pig under Indian Council of Agricultural Research. The institute being one of its type was mandated to undertake basic, strategic and applied research in the areas of pig production and health including product/by-product processing, value addition through quality control measures and transfer of the evolved technologies to the client groups. Further, the institute was also mandated to act as a repository of information on pig production and health for regional, national and global policy planning and implementation.

In Eleventh Five Year Plan (2007-2012), the Department of Animal Husbandry, Dairying and Fisheries (DADF) launched a central sector scheme namely "Pig Development" with National Bank for Agriculture and Rural Development (NABARD) as nodal organization. The scheme envisaged encouraging commercial rearing of pigs by adopting scientific methods and creation of infrastructure and production and supply of improved germplasm. The scheme also included organization of training for stakeholders to popularize scientific practices and create supply chain for meat industry with encouragement in value addition of pork for better income. In addition, the department runs a centrally sponsored scheme "Conservation of Threatened Breeds of Livestock" which also includes pig. Further, during this period the "Mega Seed Project on Pig" was launched by ICAR in 2008 with the objective of production and supply of quality swine germplasm to the farmers.

The Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India implemented a "National Mission for Protein Supplements" (NMPS) in 16 states (Andhra Pradesh, Arunachal Pradesh, Asom, Bihar, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttar Pradesh and West Bengal) during financial year 2012-13, to encourage meat production from piggery. The programme envisaged formation of 16 Pig Nucleus Breeding Units each with up to 18 Satellite Field Breeding Units. Each nucleus centre had a target to produce 5,000 piglets per year for distribution to the satellite units and other farmers for breeding purposes.

On assessment of short supply of quality germplasm, more numbers of centers under AICRP on Pig and Mega Seed Project were added in Twelfth Five Year Plan (2012-2017). Presently, there are 15 AICRP and 8 Mega Seed centers spread through different agro-climatic regions of the country.

The drivers of piggery development programmes in the country have been restricted to governmental and institutional players, like Department of Animal Husbandry, Dairying and Fisheries of Government of India, Veterinary/Animal Husbandry/Animal Resource Development Departments and Livestock Development Boards of different states and Indian Council of Agricultural Research through National Research Centre on Pig, All India Coordinated Research Project on Pig and Mega Seed Project on Pig. However, there is acute absence of private organizations involved in pig breeding and pork production on commercial scale.

Knowledge, skill and attitude (KSA) development

To encourage rural youth, Government of India has introduced several training programs for promoting piggery sector. A Centrally Sponsored Scheme "Training of Rural Youth for Self-Employment (TRYSEM)" was launched by Department of Rural Development in 1979 to provide technical and entrepreneurial skills to rural youth from families below poverty line to enable them to take up self-employment in Agriculture and allied business activities. Training is provided to the rural women under the scheme "Support to Training and Employment Programme for Women (STEP)" since 1986 by Ministry of Women and Child Development, Govt. of India. The scheme also provides incentives like quality piglets, financial support for construction of pig shed etc. after successful completion of training. Ministry of Food Processing Industries (MOFPI), Government of India also provides training on pig farming and stipend to youths of socially weaker sections. AICRP centers, ICAR-National Research Centre on Pig, Government Pig Breeding Farms, Krishi Vigyan Kendra under Indian Council of Agricultural Research (ICAR) and State Agricultural Universities, Extension Department of Veterinary Colleges are also involved in organization of training on pig farming, pork processing and its value addition.

All India Coordinated Research Project (AICRP) on Pig

AICRP on Pig started its journey during Fourth Five Year Plan (1970-1971) with the main objective of evaluating the performance of purebred under existing management conditions at the following research centers:

- Acharya N.G. Ranga Agricultural University, Tirupati, Andhra Pradesh
- Assam Agricultural University, Guwahati, Asom
- Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur, Madhya Pradesh
- Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh

During 1992-93, two more centres one at Kattupakam under TANUVAS, Chennai, Tamil Nadu and the other at Mannuthy under KAU, Kerala were added to the AICRP network. During the year 2000-2001, two more centres at ICAR Research Complex, Goa

and BAU, Ranchi were started to study the performance of indigenous pig for two generations followed by their crossbreeding with Large White Yorkshire boars.

During the Eleventh Five Year Plan, two more centres of AICRP were approved, namely Central Agricultural University, College of Veterinary Science Campus at Aizawl, Mizoram and Nagaland University, Medziphema. JNKVV, Jabalpur, Madhya Pradesh center was discontinued from AICRP programme from April 2013.

Lastly in Twelfth Five Year Plan six more centers have been added, and presently AICRP is operated at the following 15 centres across the country:

- Assam Agricultural University, Guwahati, Asom
- Sri Venkateshwara Veterinary University, Tirupati, Andhra Pradesh
- Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh
- Kerala Veterinary and Animal Science University, Mannuthy, Kerala
- Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam, Tamil Nadu
- Birsa Agricultural University, Ranchi, Jharkand
- ICAR-Central Coastal Agricultural Research Institute, Old Goa, Goa
- Central Agricultural University, Aizawl, Mizoram
- Nagaland University, Medziphema, Nagaland
- Krishi Vigyan Kendra, ICAR-NRC on Pig, Dudhnoi, Goalpara, Asom
- ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Island
- Central Agricultural University, Imphal, Manipur
- Indian Veterinary Research Institute, Eastern Regional Station, Kolkata, West Bengal
- ICAR Research Complex for NEH Region, Tripura Centre, Agartala, Tripura
- ICAR Research Complex for NEH Region, Barapani, Shillong, Meghalaya

Objectives

During Fourth and Fifth Five Year Plan, research work was carried out with the exotic breeds of pig (Large White Yorkshire at Tirupati and Jabalpur and Landrace at Guwahati and Izatnagar) with the following objectives:

- To assess various genetic parameters of economically important traits of existing exotic breeds (Landrace and Large White Yorkshire) of pigs in India with respect to production, reproduction and efficiency of feed utilization.
- To investigate the effect of protein energy ratio on production of pigs and to evolve a low cost and reasonably economic pig feed for different regions.
- To study the occurrence of pig diseases with a view to devise suitable control measures against the same.

By the end of Fifth Five Year Plan, urgent need for improvement of indigenous pig was realized in view of their large number and socio-economic importance. The need for development of superior pigs with resource use efficiency was felt as priority. Therefore, to give a multidisciplinary approach in pig production, the technical

programme of AICRP on Pig was completely remodeled in the beginning of Sixth Five Year Plan to undertake research first on indigenous pig and then subsequently on the crossbreeding between indigenous with appropriate exotic breeds with the following objectives:

- To study the performance of indigenous pigs under optimal management conditions.
- To produce crossbred by crossing indigenous gilts with exotic boars and to assess their performance in respect to their efficiency of feed conversion, production and reproduction.
- To formulate economic ration incorporating locally available feed ingredients.
- To select animals from within half-breds with faster growth on economic ration(s) to produce superior strains of improved pigs.
- To study the incidence of diseases in pigs, so as to suggest priority areas for undertaking research to provide optimum health care.

The technical programme was followed till Tenth Plan with the same objectives for production of crossbred pigs.

The technical programme was refined in view of the objectives of the programme at AICRP Meet at College of Veterinary and Animal Sciences, Mannuthy during June 2007 as follows:

- *Inter-se* mating in small population is not appropriate. Replacement of males must be practiced to avoid inbreeding.
- Early weaning as early as 4 weeks of age should be practiced providing all nutritive feed supplements in creep ration.
- Region based shelter management should be adopted.
- Integrated farming system may be adopted in order to economize production and transfer to field units. Stocking density/ha area of land for pig cum fish may be calculated.
- Efforts need to be adopted to reduce overall mortality below 10% level. Meteorological data need to be recorded in order to forecast the disease outbreaks so that appropriate prevention measures can be adopted.
- Region based suitable developed economic feed formula(e) is (are) need to be adopted.

To streamline and maintain uniformity among different centers and to finalize work plan of new centers, detailed technical programme against the objectives was chalked out and recommended during Annual Review Meet of AICRP on Pig at Goa, 2016.

Breeding programme

- The centres should initiate registration of indigenous pig germplasm in collaboration with ICAR-NRC on Pig and ICAR-NBAGR, Karnal.
- Crossbred animals of 75% exotic inheritance should be maintained.
- Minimum 30 breedable sows per unit should be maintained with a sex ratio of 1:3 and thus 10 sires (2 sires from each 5 unrelated sire lines) need to be maintained by each centre.

- Selection of male animals should be based on weaning weight (best 25%) and 8 month body weight (best 5%), based on two stage sequential selection. Selection of female animals should be based on dam's litter size at birth (>7) and weaning weight (best 25%) and number of functional teats (at least 6 pairs of functional teats).
- The males should be selected after cyto-genetics screening.
- Generation-wise data should be maintained for calculation of genetic gain and selection differential.
- Three number of farrowing per sow needs to be recorded. Three farrowing per sow should be completed in 2 years. Lifetime production traits should be recorded.
- Artificial insemination should be strictly implemented at all centers. Required extender for dilution of semen may be obtained from ICAR-NRC on pig.
- Sire exchange programme among the different centers or introduction of new germplasm may be undertaken.

Nutrition, physiology and management

- Field level validation and documentation of existing feeding packages developed by AICRP centres need to be carried out.
- Database should be developed on locally available feed resources and their utilization in pig feeding.
- Efforts should be made to develop location-specific technologies for farmers to reduce the heat stress of the animals in changing climate scenario. Recording of daily micro- and macro-climatic data (temperature, humidity and calculation of THI) needs to be undertaken.
- The centers should work on shelter management and develop technologies to combat heat stress.
- Each of the AICRP centre should explore the possibility of adopting villages for technology validation and transfer.

Health management

- Regular monitoring of the pig herd for emerging and infectious diseases should be undertaken in collaboration with ICAR-NRC on Pig/National Institutes.
- Proper management care should be taken up to reduce pre-weaning (up to 42 days), post-weaning (42 days to 5 months) and adult (5 months to 8 months) mortality so as to keep it below 10%, 5% and 2%, respectively.
- Appropriate biosecurity measures at the farm shall be maintained to reduce pre- and post-weaning mortality.

Major achievements of AICRP on pig

- The AICRP on Pig centers act as a conservation unit of registered indigenous pig germplasm like Ghungroo, Niang Megha, Agonda Goan, Nicobari, Doom and Tenyi Vo.

- Successful raising and multiplication of exotic breeds of pig, viz. Large White Yorkshire, Landrace and Hampshire under organized farm conditions.
- Genetic improvement of indigenous pigs through selective breeding especially for litter size and growth rate traits.
- Development of crossbreds of varying exotic inheritance with consistent superior performance with respect to traits notably litter size and weight, growth rate, back fat thickness and better feed conversion efficiency.
- Successful incorporation of piggery in integrated farming system with considerable economic gain.

Impact assessment

AICRP on Pig has made meaningful and sizable studies by generating enough information and necessary knowledge on pig production and productivity under Indian conditions. Significant research has been conducted specially in the field of breeding and genetics, nutrition, reproduction, disease and health management under farm and field conditions in indigenous and exotic breeds of pigs and their crosses. However, owing to limited scope and specific programme of the project, progress on many important aspects of pig production and productivity especially pertaining to economic and commercial aspects, efficiency of production, sustainability and environmental footprint, meat products technology and standardization of meat and meat products from the quality production point of view are still slow. Comprehensive information and knowledge on wholesome development of all these aspects needs attention.

Documentation, description, characterization and definition of all types of pig genetic resources are also required for creating a knowledge base as well as for their further sustainable use. Critical gaps also exist in the availability of scientific data and knowledge in some of the other key areas of biotechnology, molecular genetics and transgenesis.

Future direction

- Maintenance of region specific crossbred pig of desired level of exotic inheritance and to stabilize the performance.
- The centres should give due importance to characterize indigenous pig germplasm available in the respective states. Registration of these breeds with National Database need to be done after proper characterization and documentation.
- Nutritional experiment needs to be continued to formulate economic ration for profitable pig production.
- Adoption of integrated farming system at farmers' level by incorporation of fisheries and agriculture with piggeries need to be promoted. Development of integrated farming system demonstration unit at the centre will serve as a model for the farmers.
- Mass awareness programme on improved pig production need to be intensified to attract rural mass in piggery. Besides various on-campus and off-campus trainings, provision of consultancy service to the farmers will also help to boost up piggery sector.

Mega seed project on pig

The Mega Seed Project was launched in Eleventh Five Year Plan and started functioning in 2009 for production and supply of quality pig germplasm to the farmers with the following objectives.

- Production of 900 piglets per year by each unit to target production of quality pig covering 300 farm families per annum.
- Capacity building in institutes to produce above number of quality piglets.
- Initiating gender friendly pro-poor growth through improved pig husbandry
- In Twelfth Five Year Plan, four more centres have been added and presently Mega Seed Project is operating in 8 different centers as follows:
  - Assam Agricultural University, Guwahati, Asom
  - Birsa Agricultural University, Ranchi, Jharkhand
  - ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema, Nagaland
  - State Animal Husbandry & Veterinary Farm Complex, Aizawl, Mizoram
  - Kerala Veterinary and Animal Science University, Pookode, Kerala
  - Pig Breeding Farm, Animal Resource Development Department, Government of Tripura, Agartala, Tripura
  - Pig Breeding Farm, Namsai, State Animal Husbandry and Veterinary Department, Government of Arunachal Pradesh
  - Chhattisgarh Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh

The impact of Mega Seed Project on Pig during last few years was found to be significant in terms of supply of developed variety of piglets to the farmers. Large numbers of farm families have been benefited through the project. Capacity building of the unemployed rural youth by different Mega Seed centers has helped to take up piggery as a way of livelihood among them.

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6

Crossbred Pigs Developed in India

PIGGERY developmental programmes undertaken by central and state departments namely Department of Animal Husbandry, Dairying & Fisheries (DADF) of Government of India, Veterinary, Animal Husbandry, Animal Resource Development Departments of different states and research organizations viz. ICAR, CAU, SVUs/SAUs have resulted in noticeable progress over the time. Genetic improvement programme was the important pillar of this programe which has been remodeled based on farmers' choice and societal demand. During the initial period of development, focus was on genetic improvement of indigenous pig through selective breeding. Subsequently, exotic breeds were imported to India and efforts were made to stabilize their performance in agro-climatic conditions of the country. Consequent to slow progress of genetic improvement in indigenous pigs and higher demand for pork, crossbreeding of native pigs with exotic boars gained momentum in different parts of the country.

Many crossbred pig strains (Figs. 6.1 a-j) have been developed by different Government and private organizations. Different crossbred pigs developed over time are presented here.

Two breed crosses

Jharsuk/Tamworth and Desi Cross (T&D): Jharsuk earlier known as Tamworth and Desi (T&D), was developed by Birsa Agricultural University, Ranchi, Jharkhand by crossing Tamworth and local pigs of Jharkhand with 50% exotic inheritance. Jharsuk pig is black and has faster growth rate and better reproductive performance. The animals are well adapted to prevailing production system of the state of Jharkhand as well as its neighbouring states viz. Bihar, West Bengal and Madhya Pradesh. Disease incidences of T&D pig is comparatively low. Because of higher economic return, it has been widely accepted by the local farmers of Jharkhand and neighbouring states.

Performances of T&D cross:

Litter size at birth (no.)	8-12
Litter size at weaning (no.)	7-9
Birth weight (kg)	1-1.5
Weight at 2 months (kg)	10-12
Weight at 6 months (kg)	50-60
Weight at 12 months (kg)	120-140
Farrowing interval (days)	180-200

Rani: Looking to the high potential of piggery sector for multipliers on one hand and lack of sufficient number of high performing improved pig germplasm on the other, a breeding programme was initiated in 2009 at the ICAR-National Research Centre on Pig, Guwahati, by using Ghungroo as indigenous germplasm and Hampshire as exotic germplasm with 50% exotic inheritance. *Inter se* mating of developed variety for six generations resulted in stable production performance and development of crossbred variety Rani. The developed variety is well accepted by the commercial rearers and farmers of different states of northeastern India because of its higher economic return, ease of rearing and better adaptability to local climatic condition. It is expected that the cross will be able to partly address the requirement of superior pig germplasm of the country.

Performances of Rani cross:

Avg. Litter size at birth (no.)	9.86±0.25
Avg. Litter weight at birth (kg)	10.89±0.26
Avg. weight/piglet at birth (kg)	1.14±0.03
Avg. Litter size at weaning (no.)	8.81±0.40
Avg. Litter weight at weaning (kg)	59.88±1.92
Avg. weight/piglet at weaning (kg)	6.93±0.27
Age at first heat (days)	201.65±6.65
Age at first service (days)	239.78±5.56
Weaning period (days)	42
Gestation period (days)	114.59±0.21
Pre-weaning growth rate (g/d)	137.85±7.52
Post-weaning growth rate (g/d) (weaning to 8 months)	326.63±16.4
Weight at 8 m of age/slaughter (kg)	71.55±1.05
Pre-weaning mortality rate (%)	5.2%
Post-weaning mortality rate (%)	4.83%
Hot carcass weight (kg)	66.47±4.22
Dressing percentage (%)	74.00±0.98
Carcass length (cm)	92.88 ±4.44
Loin eye area ($inch^2$)	4.12±0.32
Backfat thickness (cm) at 10^{th} rib	1.98±0.27

Hampshire-Niang Megha Cross (HN Cross): A breeding programme was initiated in 2009 at ICAR- National Research Center on Pig to develop suitable variety for hilly region of northeastern India by using Niang Megha as indigenous germplasm and Hampshire as exotic germplasm. Hampshire-Niang Megha Cross (HN Cross) was developed through *inter se* mating and selection. Earlier, similar type of experimentation was also conducted by ICAR Research Complex for North Eastern Hill Region, Barapani. The developed variety is popular among farmers of hill region of northeastern India.

Performances of HN cross:	
Litter size at birth (no.)	6.94±0.61
Litter weight at birth (kg)	5.89±0.61
Weight/piglet at birth (kg)	0.84±0.06
Litter size at weaning (no.)	6.63±0.61
Litter weight at weaning (kg)	38.68±4.03
Age at first heat (days)	270.52±6.85
Age at first service (days)	311.51±7.96
Gestation period (days)	114.38±0.59
Pre-weaning growth rate (g/d)	122.45±6.31
Post-weaning growth rate (g/d) (weaning to 9 months)	240.87±20.35
Weaning weight (kg)	5.56±0.12
Weight at 8 months of age/slaughter age (kg)	57.48±1.62
Pre-weaning mortality rate (%)	2.63%
Post-weaning mortality rate (%)	2.22%
Hot carcass weight (kg)	54.24±3.26
Dressing percentage (%)	75.70±0.60
Carcass length (cm)	87.00±6.54
Loin eye area ($inch^2$)	3.20±0.25
Backfat thickness (cm) at 10^{th} rib	2.92±0.37

HD-K75: The All India Coordinated Research Project (AICRP) on Pig at Asom Agricultural University, Khanapara has developed HD-K75 crossbred pig variety by crossing with Hampshire and indigenous pigs of Asom with 75% exotic inheritance. The variety has gained popularity among the farmers of Asom and different parts of the northeastern states due to its high production potential, consistency in performance and adaptability to local climatic condition. This variety of pig is black in colour usually with a white belt in shoulder.

Performances of HD-K75 cross:	
Litter size at birth (no.)	8.34±0.15
Litter weight at birth (kg)	8.26±0.18
Weight/piglet at birth (kg)	0.99±0.01
Litter size at weaning (no.)	8.00±0.19
Litter weight at weaning (kg)	81.22±1.87
Weaning weight (kg)	10.13±0.01
Weight at 8 months of age/slaughter age (kg)	73.41±0.28

Dressing percentage (%)	68.95±1.13
Carcass length (cm)	69.06±0.73
Back fat thickness (cm) at 10th rib	2.58±0.17

Two breed crosses developed at different AICRP centers

Under All India Coordinated Research Project (AICRP) on Pig, initial focus was given on characterization and improving the performance of indigenous pigs under existing management conditions by undertaking genetic improvement programme through selective breeding. In parallel, exotic pig breeds namely Large White Yorkshire (LWY), Hampshire, Large Black, Duroc, Tamworth etc. were imported over time and adapted to the local production systems which showed satisfactory performance and adaptability. Genetic gain was found to be slow in native pigs through selective breeding. Subsequently, it was decided to resort to crossbreeding of native pigs. Large number of genetic groups, e.g. Large White Yorkshire, Hampshire, Landrace, Large Black, Duroc, Tamworth of 50, 62.5, 75 and 87.5% exotic inheritance have been developed by different units of AICRP on Pig spread over diverse agro-climatic regions of the country. Based on research experiences of AICRP on Pig since its inception, it was found that LWY, Hampshire and Tamworth breeds are most suitable as improver breeds for small-holder production systems as well as for organized farms. The study was conducted based on production and adaptability performance in different agro-climatic conditions of the country. In recent times, AICRP on Pig centres are mandated to maintain 75% exotic inheritance in their crossbreeding programme. Following are the crossbreds available in different AICRP centers:

AICRP centre	Crossbred maintained
Kerala Veterinary and Animal Science University, Mannuthy, Kerala	Crossbred of 75% exotic inheritance of Large White Yorkshire with local pigs of Kerala
Sri Venkateshwara Veterinary University, Tirupati, Andhra Pradesh	Crossbred of 75% exotic inheritance of Large White Yorkshire with local pigs of Andhra Pradesh
ICAR-Central Coastal Agricultural Research Institute, Old Goa, Goa	Crossbred of 75% exotic inheritance of Large White Yorkshire with Agonda Goan pigs of Goa
Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh	Crossbred of 75% exotic inheritance of Landrace with local pigs of Uttar Pradesh
Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam, Tamil Nadu	Crossbred of 75% exotic inheritance of Large White Yorkshire with local pigs of Tamil Nadu
Central Agricultural University, Aizawl, Mizoram	Crossbred of 75% exotic inheritance of Large White Yorkshire and Zovawk
Nagaland University, Medziphema, Nagaland	Crossbred of 75% exotic inheritance of Hampshire and Tenyi Vo/Nagaland local pigs

Three breed crosses

Asha: To mitigate the gap between demand and supply of quality (lean) pork and pork products, a breeding programme was initiated in 2009 at ICAR-National Research Centre on Pig to develop a suitable finisher pig by crossing Rani (Hampshire ×

Ghungroo) with Duroc as terminal sire for finisher producers. Asha was developed with 25% Hampshire, 25% Ghungroo and 50% Duroc inheritance. The pre- and post-weaning growth rate was 173.19±9.19 and 379.23±22.15 g/d, respectively. Weaning (6 wks) and slaughter weight (8 m) were 8.03±0.40 and 76.26±5.02 kg, respectively. Pre- and post-weaning mortality was 2.0 and 4.0%, respectively. The hot carcass weight, dressing percentage, carcass length and back-fat thickness of the developed variety was 70.26±1.28 kg, 75.74±0.63%, 113.8±3.52 cm and 2.34±0.08 cm, respectively. Developed Asha cross is presently undergoing field validation. The animals showed significantly higher body weight and high pre- and post-weaning growth rate at organized farm as well as farmers' field than existing two-breed crosses. Interim performance appraisal of this cross indicates enough promise to meet the demand of finisher pig producers for superior stock which may narrow the demand-supply gap.

Three way synthetic pig developed by TANUVAS, Chennai

Developing a synthetic strain of pig for productivity enhancement was undertaken by Livestock Research Station, Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam. A synthetic strain was developed by crossing female of 75% crossbred population of Large White Yorkshire and Local with Duroc males. The eight months body weight of the developed variety is 82.37±2.14 kg. The average carcass weight was 55.83±1.26 kg with dressing percentage of 66.74%. The backfat thickness of the developed variety is 2.53±0.80 cm. The feed conversion efficiency and lean meat production is reported to be better than parental line of Large White Yorkshire pig.

Three way synthetic pig in Kerala and Karnataka

Kerala Livestock Development Board (KLDB) has also developed three way cross by crossing Landrace and Large White Yorkshire F_1 cross females with Duroc sire. More recently, a commercial firm registered in Karnataka has also produced three breed syntactic strain for commercial purpose.

Achievements of breeding experimentations

Significant achievements made in pig breeding and production under different developmental programmes are discussed here.

- Breeding technologies were developed for production of following genotypes/genetic groups:
  - Improved indigenous pigs
  - Hampshire crossbreds carrying 75% and 50% inheritance
  - Large White Yorkshire crossbreds of 25%, 50% and 75% inheritance
  - Landrace crossbreds of 75% and 50% inheritance
- Exotic pig viz. Hampshire, Large White Yorkshire and Landrace could be successfully raised and multiplied under organized farm conditions.
- Genetic improvement of indigenous pig through selection programme was conducted

in all the AICRP centers spread over different agro-climatic regions.

- Litter size at birth and weaning showed continuous improvement over the years. Similarly, the growth rate and body weight at 8 months of age have also increased significantly under scientific management.
- All groups of crossbred had higher litter size and weight, growth rate and better feed conversion efficiency than majority of indigenous pigs.
- The crossbreds have lower back-fat thickness and higher lean cuts in their carcasses than the indigenous pigs.
- The three-breed cross with Duroc as terminal sire was found to be most promising in terms of body weight gain and lean meat production.

Fig. 6.1. (a). Developed Rani cross of ICAR-NRC on Pig; **(b).** Developed HN cross of ICAR-NRC on Pig

Fig. 6.1. (c). Hampshire × Tenyi Vo crossbred piglets at AICRP centre, Medziphema; **(d).** HD-K75 lactating sow with their piglets at AICRP centre, Guwahati

Fig. 6.1. (e). Large white Yorkshire × Agonda Goan crossbred pigs at AICRP centre, Goa; **(f).** Large White Yorkshire × Zovawk crossbred piglets at AICRP centre, Aizawl

Fig. 6.1. (g). Large White Yorkshire × local crossbred sow with piglets at AICRP centre, Tirupati; **(h).** Landrace cross grower at AICRP centre, IVRI, Bareilly

Fig. 6.1. (i). T&D Cross at AICRP centre, Ranchi; **(j).** Asha cross at ICAR-NRC on Pig

SECTION-III
Strategies for Genetic Improvement

7

Selection and Breeding Strategies for Pig

BREEDING strategies are going to have different consequences for the herd, and wise producers will pick a strategy that fits their philosophies and goals. No single strategy fits all situations, but each strategy is a wise choice for certain goals and production systems. The success of efficient pig farming depends upon choice of good animal for breeding purpose to get improved animals in subsequent generations with higher productive and reproductive performance and subsequently better economic returns. Most of the pig population in India is of local type with smaller body size and slow growth rate and there is non-availability of well developed, good performing pig breeds. For pork industry as well as backyard rearing there is need for development of superior swine germplasm by efficient breeding intervention.

The aim of the animal breeder is to bring about change in the genetic composition of populations so that the animals are able to fulfill the production or economic requirements of the producers. There are two broad ways by which the breeders can bring genetic improvement:

I. The choice of individuals to be used as parents of next generation (progeny) which constitutes selection.

II. The control of ways by which the parents (or populations) are mated to produce the progeny which constitutes the mating system or system of crossing.

Selection is the *"Key stone in the arch of animal improvement"*. Selection does not produce any new gene. It changes the frequency of the desired gene and thus causes desired genetic combination which results in increase in mean phenotypic value of the desired traits in a population.

Basis of selection

The choice of selection procedure should be such that it would give maximum response in terms of genetic gain. The pigs in a selection experiment can be chosen on following bases:

i. **Selection on the basis of individual performance/individual selection:** It is based on the principle "like begets like". The individual performance of an animal is considered for this type of selection. This mode of selection gives highly encourageable results for highly heritable traits like carcass trait *viz.* backfat thickness where heritability is very high (h^2>0.5). Individual selection based on productive traits *viz.* average daily gain where heritability is moderately higher (h^2>0.3) will also give better response in progeny.

ii. **Selection on the basis of collateral relatives/family selection:** When the individual is judged on the basis of deviation from the average of its own family, the selection is

known as within family selection. When along with family performance, individual's own performance is considered the selection scheme is known as between-family selection.

iii. **Selection on the basis of progeny performance/progeny testing:** In this process, animals are selected on the basis of performance of their progeny. The accuracy of progeny testing increases by increasing the number of progeny in the selection scheme. Lower heritable traits are generally selected by progeny testing. Reproductive traits in pig *viz.* litter size at birth is lowly heritable (h^2<0.2) and hence selection based on progeny testing will be helpful.

Important economic traits of pig for selection

Selection of superior animals can be done by considering following points:

i. **Body conformation traits:** The physical factors which are associated with the body conformation and general appearance of the animal are the basic indicators for selection.

   a. **Boar selection:** Generally, boars with 90 kg body weight and length not lesser than 100 cm are preferred for breeding though relaxation can be given to the above traits for Indian breeds as per their body conformation. Generally animals with maximum weight at 6 months of age are preferred for breeding. The breeding boar must have well developed testes, stout body and wide apart strong legs, high vigour with active look and free from diseases and any physical defect. Boar should not be used for breeding purpose until it reaches 28 to 30 weeks of age. Selection of boar should be done with utmost care with maximum selection intensity.

   b. **Sow selection:** Selected gilts must have good breed characteristics of a breed. Females with wide apart legs, developed shoulder, arc back are preferred for breeding. The selected gilts must have at least six pair of functional teats, adequate length and depth of the body, thick, well muscled hams and prominent neck. Animals with history of good litter size and weight in pervious farrowing, superior temperament and mothering ability are preferred for breeding.

ii. **Performance traits:** Individual performance traits are important for selection programme. Following performance traits are important for pig breeding:

   a. **Litter size at birth and weaning:** About fifteen to twenty eggs released by a sow during ovulation may be fertilized. Several of the resulting foetuses or embryos may eventually die. Due to its low heritability, the genetic control of litter size is very limited. Large litter size is essential for efficient pig production. The weaning of a large litter size indicates a high ovulation rate, absence of unusual embryonic mortality, a satisfactory mammary system and presence of good mothering ability. The litter size at birth varies from 2 to 18 under Indian conditions depending upon the choice of breed. Under average farming condition, a moderately performing breed/variety of pig breed gives eight to ten piglets per litter. The litter size at weaning should be 7 to 9 for optimum performance under Indian conditions. However, breed-specific target for this trait can be fixed before selection.

   b. **Litter weight at birth and weaning:** Weight is one of the main criteria for selection. A measure of the fecundity and the milking and mothering capacity of sows, and of the suitability of the pig's environment, can be obtained by weighing litters. The

selected animals must have better litter weight at birth and weaning as compared to non-selected population. The number of pigs weaned and their weaning weight is certainly important in profitable pig production and is influenced by genetic makeup. Weaning weight may be influenced by nursing sows capacity for milk production, mothering ability and the environmental factors like feeding and management practices. The breeder must strive for lower mortality and good health in suckling pigs.

c. **Pre- and post-weaning growth rate:** Growth rate is one of the major factors for selection as animals with higher post-weaning growth rate and feed conversion efficiency will result into better economic return. Post-weaning growth rate is more heritable than litter size or weaning weight and thus selection based on these characters gives more genetic gain. Selected animals with higher growth rate must be separated to study the growth performance.

d. **Feed conversion efficiency:** This trait has high positive correlation with growth rate. It is the ability of the pig to convert feed into meat and fat. Marked genetic variation exists between and within breeds and improvement can be realized by selection of breeding stock. Feed conversion efficiency is affected by the nature of ration, sex, environmental temperature, management practices and genetic make-up of pigs. Generally, an animal weighs 90 to 100 kg in 8 to 10 months of age with feed conversion efficiency 3.5 to 4.0. During breeding plan formulation, selection criteria can be fixed on the basis of performance of locally available germplasm.

e. **Number of litters born per year:** Total number of litter per year is a good indicator of productivity of the farm. If early weaning of piglets between 4 to 6 weeks is practised, three litters can be achieved within two years of age under Indian conditions.

f. **Other reproductive traits:** Age at first estrus, weight at first estrus, age at first service, age at first fertile service, age at first farrowing, gestation period, service period, inter-farrowing interval etc. are the other reproductive traits to be considered for selection. Selection criteria of these traits can be fixed to the upper limit in the selected population than the non-selected animals.

iii. **Carcass traits:** The carcass quality is the indicator of growing process which involves the pre- and post-weaning growth rate and growth ratio of development of bone, muscle and fat tissue. Genetic selection within breed has basically produced strains of pigs suitable for market requirements. Mostly markets require minimum fat and maximum lean tissue in pork. Most of the carcass traits are highly heritable in pigs and thus the genetic gain based for selection based on carcass trait is higher.

a. **Carcass length:** It is the length between first rib to aitch bone (rump bone) of the animal. The carcass length is positively correlated with loin-eye cut of the carcass. A 90 to 100 kg pig should not have lesser than 75 cm carcass length.

b. **Loin-eye cut:** It is the area of *longissimus dorsi* muscle of the animal which runs by the side of vertebra. This parameter is best indicator for muscling in the carcass. A transverse section of loin area (between 10^{th} and 11^{th} rib) is cut and muscle area is measured for this parameter. Normally a 90 to 100 kg pig must have 25.5 sq. cm of loin-eye cut area.

c. **Backfat thickness:** It is the average of backfat of first and last rib and the last lumber vertebra of animal. The ideal value of backfat thickness should be less than 3.8 cm for a 90 to 100 kg animal. In most of the cases in commercial farming lesser backfat with maximum lean meat is preferred. Backfat of live animals can be measured by probe or by ultrasonic technique. These estimates of backfat thickness of the live animal supplemented with visual appraisal are useful for selection of breeding stock for lean pork production.

d. **Primal cut percentage:** It is the percentage of loin, ham, shoulder butt, picnic shoulder and belly cut of the animal. The ideal population selected for breeding purpose must have primal cut area of more than 52.8 % of total body weight.

The carcass traits for selection may be fixed based on size of indigenous animals.

iv. **Adaptive traits**

a. **Pre- and post-weaning mortality:** Mortality is one of the most important limiting factors for profitability of pig farm. Generally crushing, chilling, pneumonia and gastroenteritis are the main causes of pre- and post-weaning mortality. For proper monitoring of the farm, mortality should be checked. Sometimes the pre-weaning mortality is caused by poor mothering ability of the sows. The sows with history of poor mothering ability should be avoided for further breeding.

v. **Important genetic disorders**

Due to presence of certain lethal and semi-lethal genes, the overall performance of the farm decreases. The animals that are carrier of genetically controlled disease(s) must be avoided for breeding purpose. The important genetic disorders of swine are cryptorchidism (absence of one or both testes from the scrotum), hermaphroditism (presence of both male and female rudimentary sex organ), atresia-anai (absence of anus), hydrocephalus (fluid in brain), leglessness, posterior paralysis and reproductive-organ abnormality. Animals with history of such diseases in last three pedigrees should be avoided for breeding purpose. Scrotal hernia and inverted nipples are also undesirable in profitable pig farming. Since these traits are known to be heritable, animals with these types of deformities should be discarded from breeding. Genetically controlled disorders can be removed by selective breeding among the stock.

Methods of selection

i. **Tandem selection:** When the selection is practiced for one trait at a time until satisfactory improvement is achieved, it is known as tandem selection. When desired improvement of a trait is achieved, the other trait is taken into consideration by this method. The main disadvantage of this method is that it is time consuming and not compatible for negatively correlated traits; which results in decrease in performance in correlated trait when other gives improved response.

ii. **Independent culling level:** By this method, selection is made simultaneously for all the characters independently by rejecting the individual for selection which fail to meet the minimum standard for a trait. In this method, a cut-off value is assigned to each trait under consideration. The main disadvantage of this method is that it does not permit to compensate the inferiority of one trait at the cost of other superior trait.

This method of selection can be used in pigs in Indian context due to absence of proper data recoding in farmers' field.

iii. **Selection index or total score method:** Selection is made for all the traits simultaneously by using a total score or index by giving some economic value for the traits to be considered. The amount of score given to each trait depends upon its relative economic value, heritability and genetic and phenotypic correlations of the trait with other correlated traits. This is the most efficient among the methods. It allows superiority of some traits to make up for slight inferiority in other trait. This method can be used in scientific piggery intervention after collecting all the records.

System of mating

Inbreeding is to be avoided due to its adverse effect on the performance of the animals. Out of different types of out-breeding system, grading up and crossbreeding are generally adopted in swine breeding practice.

i. **Grading-up:** In this method, non-descript sows are mated with superior boars of a well developed breed from generation after generation. After the seventh generation of crossing, the indigenous non-descript animal will have more than 99% inheritance of the breed of superior boar. As most of the pig population of the country is non-descript type, this method of breeding shall be beneficial for genetic improvement. This method of breeding is also useful where high quality pure breeds cannot be maintained due to poor management and feeding conditions. One of the major limitations of this method is the adaptability of the superior breed to acclimatize in local climatic condition which may result in comparatively lower performance of the progeny.

ii. **Selective breeding:** This is a method of breeding where superior male and female animals within a breed are selected and mated. This method is useful for increasing the performance of a developed breed. For conserving indigenous germplasm and to maintain pure stock of indigenous animals this system of mating should be followed.

iii. **Crossbreeding:** This is the method of crossing between two well developed breeds. Crossbreeding is a widely accepted and recommended practice in commercial pig production. It is used to capitalize on heterosis, the superiority of crossbred individuals over the average of their purebred counterparts. The crossbred progeny shows increase in litter size and weight at birth and weaning, increase in growth rate and feed conversion efficiency and optimum carcass traits. Crossbred sows are superior mothers and have the ability to produce more milk to nurse a large-sized litter. Commonly used crossbreeding system in pig production are:

Two breed crosses: This is a system of mating in which purebred animals of two different breeds are used for crossing.

Back cross and criss-cross system: It is the mating of crossbred animals (F_1) to purebred animal of either parent breed. This cross is made to exploit maternal or paternal heterosis. The back crossing between crossbred female and purebred males shows 100% maternal heterosis. The offspring crossbred gilts are mated back to a boar of one or other of the two original breeds.

Three breed cross: In this system of crossbreeding, three breeds are rotationally used and males from each of the three breeds are used in succession on crossbred females.

Four breed crosses or double two breed cross: This involves the crossing of crossbred females produced by crossing two breeds (A & B) with crossbred male produced from crossing another two breeds (C & D). Thus mating of two crossbreds (AB x CD) animals produce both maternal and paternal heterosis as well as individual heterosis.

Detection of heat and mating

The average length of estorus cycle in pig is 21 days. The length of the estrus period is 2 to 3 days. The sow can be bred round the year. During the estrus, the female shows frequent urination, lesser appetite, erection of ears, vulvar swelling and discharge, and immobility when pressure is applied to the back. The best time for service is second half of the first day and second day of heat. The female should be served twice at 10 to 12 hours interval. Mating may take 3 to 7 minutes during natural service. The gestation period is 114 days. Following parturition, sows may be mated one month after weaning by skipping post-partum heat. The boar can be effectively used up to 24 to 30 months of age while female can be replaced after third or fourth farrowing.

Record keeping

Record keeping is of immense importance for efficient farm management. Scientific management and handling of farm records helps to select the animals of higher genetic worth for further propagation in breed improvement programmes. Recording of animals in different aspects such as productive and reproductive performance, occurrence of disease, vaccination, feeding, breeding and disposal records of individual animals will help in success of pig farming. The main objective of maintaining the farm records are as follows:

- To formulate efficient breeding programme for improvement of the herd
- To evaluate the production potential of the animals
- Selection of superior animals for further propagation
- Culling of unproductive/low-producing animals
- Economic feeding of the animals
- Detection and prevention of abnormal condition like hernia, atresia-anai etc.
- Maintain the economy of the herd
- Helps in better supervision of the herd
- Comparison between different herds and periods
- Estimation of breeding value for different economic traits
- Allotment of superior sires to sows of higher genetic merit
- Knowing the health status of animals
- Estimation of input-output relationship of the herd

A comprehensive history sheet for male and female animals for data recording is given in Annexure IV and V, respectively.

Culling

One of the most important decisions in a pig farm operation is the selection of animals to be retained as replacements and culling of rest of the stock. Culling of the pigs in breeding programme is very important as most of animals, both in male line and female line, can be removed from the breeding stock. Accuracy of culling will increase the selection intensity and thus in turn increase the genetic gain. Deformed, infertile, low producing and other unwanted animal should be disposed off regularly.

Open Nucleus Breeding Scheme (ONBS)

Open Nucleus Breeding Scheme (ONBS) is a three tier system of pig production comprising of nucleus herd, multiplication herd and commercial herd. The nucleus herd actually conducts breeding and selection for the genetic improvement of specific breeds or lines. They target their selection programmes based on the needs of customers, the pork producers and processors. However, there is a time delay between the genetic improvement in the nucleus farms and the transfer of genetic gains to commercial producers through multipliers. This delay is typically 3 to 5 years and is called genetic lag. It is, therefore, very important for the nucleus breeders to evaluate the future needs of producers ahead of time and decide their breeding goals accordingly. Open nucleus breeding schemes (ONBS) should be followed as a model for pig industry in developing countries. The reasons for following ONBS are that the breeding stock is concentrated in a few herds from where the quality animals are disseminated to other units and moreover good record keeping and data management at reasonable cost, will ease the functional operation.

In order to have a successful ONBS at a large scale, use of artificial insemination (AI) with frozen semen is essential. AI using frozen or liquid semen is a prerequisite for large scale development of any animal husbandry sector. AI in pig using frozen semen still remains as a formidable challenge in India with limited success only on experimental basis.

Marker assisted selection (MAS)

Various candidate gene and quantitative trait loci (QTL) analyses have recognized substantial chromosomal regions and individual genes linked with traits of economic interest in pig. These comprise QTL for meat quality traits, back fat, growth and reproduction. Some commercially used traits for Marker Assisted Selection (MAS) in pig industry are given in Table 6.1.

Experimentations on an array of candidate genes for various economic traits including fitness and adaptability can easily be mixed in a large scale coordinated breeding programme. Combined studies and experimental work carried out at National Research Centre on Pig on a limited scale has indicated the probability of oestrogen receptor (ESR) and follicle stimulating hormone beta subunit (FSHb) genes as candidate markers in Ghungroo breed of indigenous pigs. Niang Megha and Ghungroo, the two popular local breeds are free from recessive mutation in halothane gene (candidate marker) accountable for Pale-Soft-Exudative (PSE) pork.

Table 6.1. Commercially used traits in marker assisted selection (MAS) in swine industry

Trait	Marker	Name	Chromosome	Patent
Litter size	Oestrogen receptor	ESR	1	yes
	Osteopontin	OPN	8	yes
	Prolactin receptor	PRLR	16	yes
Lean growth	Marker for fat	SO112	1	-
	Insulin like growth factor	IGF2	2	-
	Myogenic factor 3	MYF3	2	-
	Marker for fat	SO107	4	-
	Leptin receptor	LEPR	6	-
	Marker for fat	SO102	7	-
	Myostatin	GDF8	15	-
Meat quality	Skeletal muscle calpain	CAPN	1	-
	Calpastatin	CAST	2	-
	Halothane gene	RYRI	6	Yes
	Rendement Napole	RN	15	-
Intramuscular fat	Heart fatty acid binding protein	H-FABP	6	Yes
Immunity	Tumour necrosis factor	TNFB	7	-
	Histocompatibility	SLA-1	7	-
Coat color	Dominant white	KIT	8	yes

General consideration for pig breeding

- Inbreeding should be avoided, as 10% increase in inbreeding results to one-third lesser piglets per litter at farrowing and half lesser pig at weaning.
- Crossbreeding with proper plan can be followed to get maximum heterosis.
- In case of hand mating, the boar sow ratio should be 1:15, but in small herd or in case of non-availability of breeding boar the ratio can be increased up to 1:20.
- First one or two heat of gilts shall be skipped for breeding.
- In hand mating, sow shall be preferably bred twice with 24 hours interval.
- Proper health care and vaccination of animals can give better result for any breed improvement programme.
- Breeding herd should be free from zoonotic diseases *viz.* brucellosis and leptospirosis.
- Identification of candidate genes for economic traits and incorporating them in marker assisted selection (MAS) will improve the genetic gain for selected traits.
- All the necessary pre- and post-weaning management practices can further increase the efficiency of breeding programme.

Proper breeding strategies for formulation of state or region specific breeding plan are required for development of piggery sector of the country.

❑

8

Conservation Strategies

CONSERVATION is the management of human use of biosphere so that it may yield the greatest sustainable benefit for present time while maintaining its potential to meet the needs and aspirations over the time. Conservation of breeds is the best way to protect genetic diversity within each species, to protect unique characteristics, adaptability, and utility within a species. It includes:

- The identification and documentation of all available breeds within species
- Description and characterization of all the breeds to understand their unique qualities
- Find out the potentials of the breed to make the future contributions
- Monitoring the population statistics for each breed and determining their status with respect to effective population size
- Conserving the gene pool for future use
- Storing adequate samples in the shape of frozen semen and embryos to enable the future regeneration of a lost population
- Imparting education and training programme in conservation genetics

Concerns for indigenous pig

Pig population in India witnessed a sharp decline during the last decade from 13.52 million in 2002 to 10.29 million in 2012. Indigenous pigs (76.14%) constitute the majority of total pig population of the country. The major concerns for indigenous pig population are discussed here.

Decreasing indigenous pig population: Indigenous pig population witnessed a decline of 30.88% in last decade from 2002 to 2012 and during same time, exotic and crossbred pigs have showed an increasing trend. The continuing decrease in indigenous population may be essentially due to increasing interest of farmers towards faster growing crossbred pigs, lack of easily available and economic feed and occurrence of different diseases.

High rate of crossbreeding: The continuous decrease in pig population specifically during last decade is also attributed mainly to the crossbreeding programmes adopted by the different agencies. Low productivity of indigenous germplasm is the major concern that has resulted in increase in crossbreeding. By using exotic germplasm, indigenous germplasm is largely diluted and even some of the lesser known populations could have come under the threat.

Large non-descript population: The indigenous pig, as per livestock census (2012), consists of 76.14% of total pig population. Out of this large share of indigenous pigs only

a small *percentage* belongs to well defined breeds like Ghungroo, Niang Megha, Agonda Goan etc. Most of the indigenous pig germplasm are yet to be documented and thus largely not characterized. Registration of these populations was started during recent past.

Lack of breeding policy and its implementation: Animal Husbandry and Dairying is a state subject and necessary steps should be taken by respective departments for the growth of the sector. A sound breeding policy for development of piggery sector is not available for most of the states which hinders the improvement of this sector.

Low/non-availability of feed: Feed represents the major cost of pig production, constituting up to 70 % of the total expenditure. Non availability of low cost concentrate for piggery is a major bottleneck for development of this sector.

Lacunae in production system: Majority of pigs in India are raised in backyard/ scavenging system with negligible input. It is typically characterized by poor growth, higher mortality rate and lesser economic benefit.

Incidences of diseases: Occurrence of emerging and re-emerging diseases of indigenous and trans-boundary origin also causes decline in population size.

Mass culling: Mass culling strategies as disease control measure has significantly affected pig population of India. For example, control of Japanese Encephalitis (JE) in northern Bengal in 2014 resulted in sharp decline in Ghungroo pig population in its breeding tract.

Poor marketing and market linkage: Present pig marketing system is exploitative, collusive and economically inefficient. Low price of pork, lack of buyer and lack of market linkage are the major limiting factors for piggery sector.

Lack of scientific knowledge: Lack of technical know-how for scientific pig rearing practices to farmers is causing declining performance of the sector.

Identification, characterization and documentation of pig genetic resources

Phenotypic and genetic characterization: There is urgent necessity to identify and characterize indigenous pig population by phenotypic and genetic characterization throughout the country. Survey should be conducted to identify populations which are unique and homogenous and can be distinguished easily from other populations. Information on geographic distribution, native environment, management and utility, physical and morphometric traits and performance are required to be documented. Possible threats and risk factors for pig population are also to be identified (Chapter 3).

Molecular diversity analysis among the different breed and strains: Molecular diversity need to be analyzed among the indigenous germplasm. Genetic characterization has been carried out for Ghungroo, Niang Megha, Doom, Mali, Ankamali and Andaman Local pigs. Studies revealed high diversity as well as genetic distinctness of these populations. Moreover, all the populations are genetically diverged from exotic breeds. Microsatellite genotyping is to be carried out for remainder populations (See Chapter 3).

Information system of swine germplasm has to be developed: After phenotypic and genetic characterization and diversity analysis among the available germplasm, total gene pool of indigenous swine genetic resources need to be identified. Along with characterization a detailed and systemic inventory of pig genetic resources needs to be maintained for improvement.

Conservation methods

After identifying and characterizing the population, it is essential to monitor the population dynamics on regular basis. For the breeds or populations, which are falling in vulnerable, endangered or critical categories, immediate conservation efforts should be taken.

In-situ *conservation*: *In-situ* conservation is the maintenance of live population of animals in their native environment or as close to it as practically possible. Original genetic makeup of a breed is maintained in its native population to the fullest extent. Methods of *in-situ* conservation are discussed here.

- Development of organized herd / farm in farmers' field and village level in collaboration with NGOs / Cooperatives and different volunteer organizations to increase the awareness of a particular breed.
- Development of large-scale organized pig breeding farm at ICAR Institutes, SAUs / SVUs and CAU so that it can act as conservation *cum* demonstration unit for the specific breed. Practical demonstration and training on scientific know how of pig rearing and utility of the breed at these centers will also increase the acceptability of local pig rearing.
- More populations may be conserved by establishing the nucleus flock with the help of village Panchayat. These nucleus animals can be genetically improved through selective breeding and further elite males can be produced for breeding in field.
- Identification of boars of superior genetic merit among different breed and use its semen for artificial insemination in selective breeding programmes. This will disseminate improved germplasm in the breeding tract. The closed herds could also be opened through two-way flow of superior germplasm from the breeding tract to nucleus herds and vice-versa.
- Provision of incentive to pig farmers where the breed is comparatively low performing but have some unique traits / characters which may be subsequently used in different breed improvement programme.
- Formation of pig breeders' society to increase the awareness and interest of the farmers and develop national watch list on the population status of the breed.
- Development of herd registration scheme in pig for economic benefit of the farmers by linking the registered herd with market and value chain production system.
- The pig breeding policies of concerned states should be strengthened with proper breeding plan. Selective breeding must be adopted in populations of any well defined breeds or populations. Advanced technologies like embryo transfer technique, transgenesis, cloning for genetic improvement and conservation are also important for long term improvement and conservation programme.

- A reliable data base should be developed for different pig populations, including their breeding tracts, numbers, characterization, genetic make-up at the institutional farm where they are being preserved and conserved.

Ex-situ conservation strategies

Ex-situ, conservation is the maintaining of gene pool away from the original habitat and production systems where the resource develops.

In-vivo ex-situ method is a conservation strategy where small numbers of live animals are maintained in a closed flock away from the breeding tract. However, the major disadvantages of *in-vivo* strategies are differential performance of animals in different environment due to genotype-environment interaction, unavoidable effect of small population size like increasing inbreeding levels etc.

In-vitro conservation is the strategies where the gene pool is stored in frozen state for longer time period. This is essential for any breed at risk. Semen, live ova, embryos, somatic cells or other animal tissues, DNA can be stored.

- In India, liquid boar semen (4 to 15°C) is being used for artificial insemination having short shelf life of 3 to 7 days. Frozen semen technology with longer preservation is yet to be achieved for conservation purpose. It is recommended to preserve around 2000 doses of frozen semen each from 15 to 30 unrelated sires in order to maintain genetic diversity of a breed.
- Recommended number of embryos for cryopreservation is at least 300 per breed, with equal number of males and females. Suitable strategies for embryonic research need to be developed for indigenous pig germplasm. Genomic DNA, tissues, stem cells and whole blood may also be preserved for posterity.
- Germplasm should be preserved in designated Gene Bank equipped with all kind of cryopreservation facilities. First National Gene Bank of the country has been established at ICAR-National Bureau of Animal Genetic Resources (NBAGR, Karnal). The Bureau has also been designated as repository centre for the animal genetic resources of the country by the Ministry of Environment and Forests, Government of India, under the National Biodiversity Act (2002). Germplasm of the best animals from available indigenous pig breeds in from of semen, ova and embryo from each farm can be cryo-preserved equally at ICAR-NBAGR, Karnal and ICAR-NRC-Pig, Guwahati.

Awareness programme and conservation

Communities can play an important role in conservation and improvement programmes for any livestock breed or population. This can be helpful in creating awareness about scientific rearing among the livestock keepers involving direct participation of various stakeholders *viz.* farmers, scientists, NGOs, community leaders, local and state administration and sister organizations, and further providing basic amenities including elite animals, health care and veterinary aids, technologies. Formation of associations in native breeding tract has always been helpful in any livestock conservation programme worldwide. State governments are also implementing various centrally sponsored schemes to promote community-based conservation. Both kinds of conservation programmes need the collaboration of different agencies as well as livestock keepers' communities.

Threats and mitigation strategies

Threats	Strategies
Unidentified and non-descript pig population	• Identification of new populations, registration of these populations as a breed • Extensive survey for characterization, documentation of new populations/breeds • Strengthening the national database on pig genetic resources to enable information sharing • Estimation of effective population size
Smaller and declining population size	• Breeding strategy for increasing population • Continuous monitoring of local populations • Estimate population trends, identification of breeds under threat and preparation of early-warning and response system • Establishing nucleus farms for each breed/population • Developing breeding based long term conservation programme • Increase effective population size by increasing number of breeding males • Establishing/strengthening National/State Gene Bank as germplasm repository and cryopreservation of germplasm • Use of advanced reproductive biotechnological tools for germplasm multiplication • Developing breed societies for indigenous pigs
Lower growth traits	• Providing genetically superior males to the farmers • Utilization of superior germplasm for improvement of farmers' flocks/herds through selection • Planned breeding to improve slaughter traits • Wide spread use of artificial insemination technique with semen from selected superior male
Indiscriminate slaughter	• Restricting slaughtering, particularly mass slaughtering • Mass awareness about hygienic practice of slaughter • Development of localized slaughter house at village level
Crossbreeding	• Restricting indiscriminate crossbreeding by making "safe zones" for defined breeds/populations • Selective breeding in indigenous pigs under safe zone for increased pork production • Accept only specific planned crossbreeding program by development organizations with targeted pig population in each state
Concentrate scarcity	• Concentrate should be supplied by governments at subsidized rate • Alternate protein diet based on local ingredients should be developed
Inadequate marketing	• State Government should develop niche market for pork products • Packaging of meat products for long distance transportation • Development of cooperative based marketing system with proper market linkage
Lower economic return	• Incentive/compensation by the Government • Value addition and branding of meat products • Diversifying use of byproducts like manure and bristles • Implementation of scientific rearing practice at farmers' level with proper market linkage

Continuous decline of native pig populations is indicative of the fact that many of the indigenous pig breeds may already be facing the threat of endangerment. There is an urgent need to systemically survey, characterize, document and conserve in a holistic way involving all the stakeholders like Governmental agencies, Non-Government institutions and local communities. There is need to identify their unique attributes e.g. early sexual maturity, superior bristle character, thriving on low level of nutrition, and major attributes of pig products so that pig husbandry remains economically viable and socially sustainable venture.

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9

An Outline for Piggery Development in India

UNDERSTANDING the importance of piggery in livelihood security of rural masses of India, development of suitable policies for improving efficiency, sustainability and equity in the piggery sector of the country is the need of hour.

Objectives

- Genetic improvement of local pig breeds through selective breeding
- Conserve / maintain nucleus herd of well-developed indigenous pig germplasm
- Genetic improvement of local / non-descript animals by crossbreeding and gradually replacing the non-descript animals with crossbred germplasm of desired level of exotic inheritance

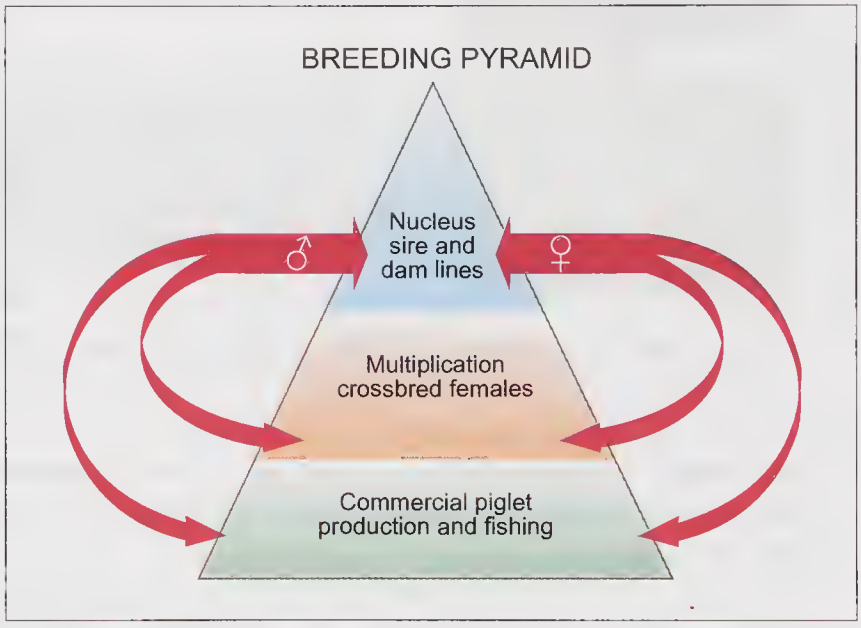

Fig. 9.1. Schematic diagram for pig breeding programme in different state

- Propagation of crossbred pigs at field condition for finisher producers
- Expansion and strengthening of breeding infrastructure and support mechanism (Fig. 9.1) to propagate elite germplasm through Artificial Insemination (AI)
- Holistic development of piggery sector w.r.t. breeding, feeding, management, housing, value addition and marketing.

Breeding plan for nucleus farm

- Nucleus farm may be of pure exotic breed, well-developed crossbred or pure indigenous breed.
- Crossbred animals of desired level of exotic inheritance should be maintained. Crossbreeding may be restricted to 50% level of exotic inheritance. However, the level of exotic inheritance may be increased in state-specific breeding programme. In case of nucleus hard of pure animals, mixing / crossing of germplasm must be restricted.

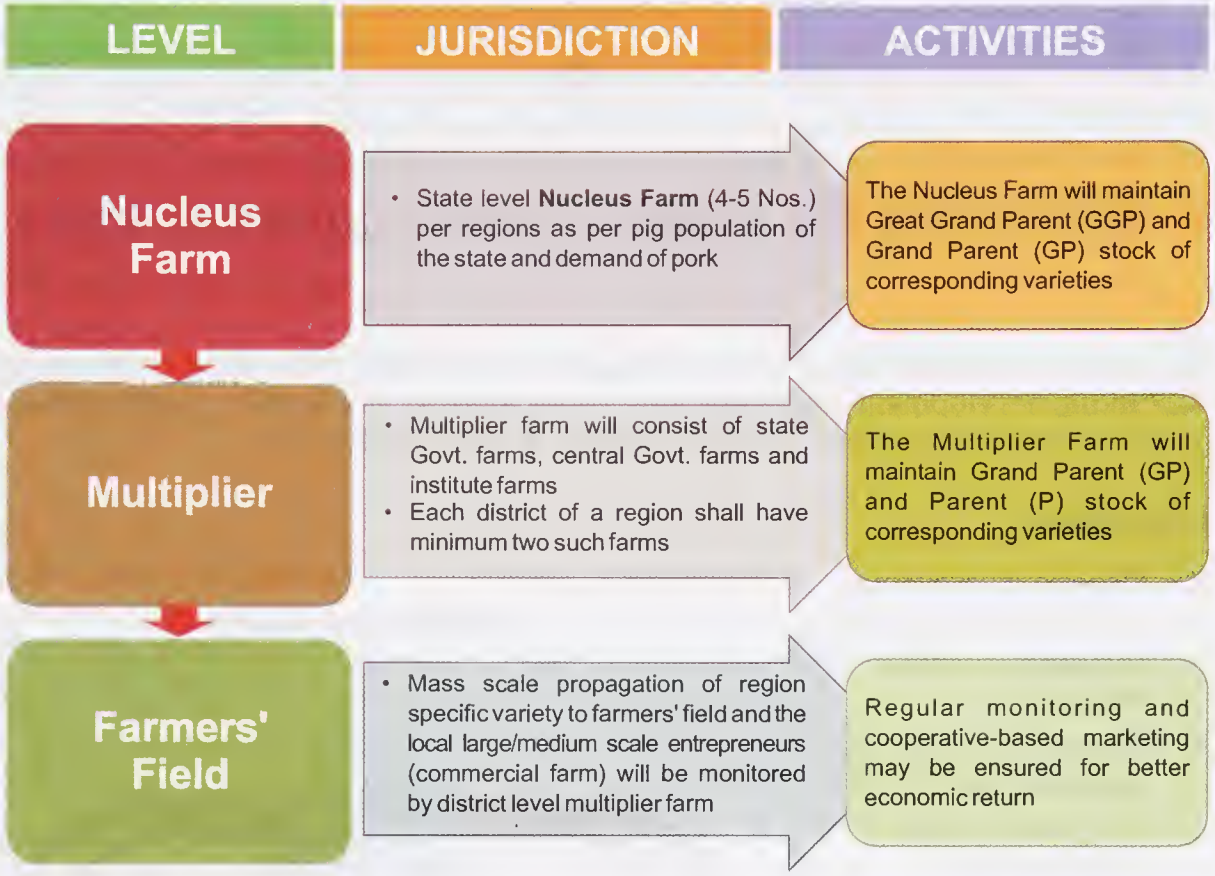

Fig. 9.2. Schematic diagram for pig breeding programme in different state

- Minimum 30 breedable sows unit should be maintained with a sex ratio of 1:3 and thus 10 sires (2 sires from each 5 unrelated sire lines) need to be maintained by each of the unit.
- Selection of male animals should be based on weaning weight (best 25%) and 8 month body weight (best 5%), based on two stage sequential selection. Selection of female animals should be based on dam's litter size at birth (>7) and weaning weight (best 25%) and number of functional teats (at least 6 pairs of functional teats). However, these can be changed as per performance of local crossbred animals.
- Centralized data recording system may be initiated. Generation wise genetic evaluation may be carried out to estimate the response to selection. The overall genetic gain due to selection, selection differential and heritability may also be calculated.
- Inbreeding should be avoided. Replacement of boars need to be done at regular interval of 2 years of productive herd life. Sire exchange programme among the farms will also be helpful to reduce the inbreeding effect. Culled male animals should be castrated before selling to avoid indiscriminate breeding.
- Three number of farrowing per sow need to be recorded. Three farrowing per sow should be completed in 2 years.

- Weightage of selection need to be given on litter size and weight at birth and weaning.
- Besides routine productive, reproductive, adaptive and carcass traits, lifetime production traits may also be recorded.

Breeding plan for Multiplier and Farmers' Farm

- Multiplier farm should maintain grandparent (GP) and parent (P) stock of desired variety. The replacement (GP and P) stock of multiplier farm should be made available from nucleus farm. Multiplier farm should produce desired animals for propagation to farmers' field (Fig. 9.2).
- Breeding plan for farmers' field should be separate with that of nucleus and multiplier farm. They are only to make inter-se-mating among the developed crossbred animals. No indiscriminate crossbreeding should be allowed at farmers' field.

Mating system

All the breeding propagation activity should preferably follow artificial insemination (AI) practice. To achieve the target, the State level Multiplier farm must have a training center for the local farmers including modest facility/laboratory for semen collection, evaluation and preservation. However, natural mating in some cases may also be adopted based on infrastructure of different states. Selection of boars in breeding programme should be based on following points:

- The breeding boars require a recorded pedigree, a quality certificate for the breed issued by the authority for boars used for AI/natural mating.
- The boars used for AI must be quarterly performance tested for semen quality.
- The minimum area for keeping a breeding boar is 5 m^2 for the local breed and 6 m^2 for the exotic breed.
- The maximum frequency of use of boars is 2 times a week for AI boars younger than two years, 3 times a week for AI boars older than 2 years, and 3 times a week for natural mating boars.
- The earliest age of use for AI or natural mating is 8 months for local boars and 10 months for exotic boars.
- AI boars should not be used for more than 3.5 years, and natural mating boars for not more than 3 years.
- The reports on the quality of these boars shall be annually sent to DADF for evaluation.
- Boars needs to be vaccinated against swine fever, pasteurellosis, foot and mouth disease and other diseases as regulated.
- A certification system should be implemented step by step for better quality breeding boars and sows for organized farms which can be recognized as certified breeding animals

Crossbred to be propagated in different region

Northern India	•	Large White Yorkshire
	•	Large White Yorkshire cross
	•	Landrace cross
Northeastern India	•	Hampshire cross
	•	Large white Yorkshire specifically for Mizoram and Tripura
	•	Triple cross with Duroc as terminal sire
	•	Large Black cross
Eastern India	•	Hampshire cross
	•	Tamworth cross (specifically Jharkhand)
Central India	•	Landrace cross
	•	Large white Yorkshire cross
Southern India	•	Large white Yorkshire cross
	•	Triple cross with Duroc as terminal sire
Western India	•	Large white Yorkshire cross

Recognition and conservation of indigenous germplasm

- **Breed registration:** All the states shall take necessary steps for breed registration of indigenous germplasm in collaboration with ICAR-NRC on Pig and ICAR-NBAGR, Karnal.
- Nucleus breeding farm for such type of indigenous registered germplasm need to be established in its breeding tract separately. Breeding pyramid should be followed for indigenous prized germplasm also.
- Prized animals may be collected from farmers' field/state/central Govt. farm to the nucleus hard.
- Pedigreed animals should be propagated only to interested farmers who want to keep local germplasm.
- No crossbreeding should be allowed to farmers' field for these prized animals.
- Separate rates and incentive from the state department may be provided to such farmers.
- Most of the indigenous germplasm are smaller in size with less litter performance. However, in specific cases, indigenous animals with higher litter size and body weight, if available, may be used for upgradation of non-descript animals with proper plan.

Culling

Bad/unproductive animals should be eliminated from each generation. Animals along with its family with specific genetic disorders should be eliminated from the breeding programme.

Traceability and disease control

A systematic process of identification, registration and recording of animals should be followed to keep track of the individual animals. Specific system should develop for pig disease surveillance and monitoring.

Capacity building

- Training of farm managers/large scale entrepreneurs on breeding management
- Regular/refresher training for technical personnel, para-vets and livestock service provider
- Training on semen collection and AI to farmers/service provider

Infrastructure building

- Provision may be kept for import/purchase of advanced machinery for feeding and watering.
- Development/provision of infrastructure at farmers' field for climate resilient housing for pigs.
- Establishment of a bacon factory in the State would reduce the transportation cost by rail and boost piggery in the State.
- Value addition of pork and pork-products should be promoted for better profitability of the farmers.
- Cooperative based market chain should be developed.
- All the states should develop specific quarantine facilities for import of animals.

Subsidies and other financial support

- Easy bank credit facility
- One time subsidy for smallholders purchasing breeding boars
- Annual subsidies for using AI services
- One time subsidy for AI service providers
- One time subsidy for waste management system
- Subsidies for the import of grand parents (GP) and parent (PS) stocks
- Price subsidies for indigenous pork producers
- Subsidies for infrastructure development
- Tax holiday for specific period for large scale commercial pig farms

Development of state specific policy and implementation

The states having significant effect of piggery in livelihood of the population should work upon as per their requirement within the frame-work of this policy considering following facts:

- Involvement of cultural and social system of the state.

- Sectoral analysis of pig rearers of the states needs to be done for the formulation of specific policy with zero input, low input and intensive pig farming system.
- Formulation of state-specific breeding plan should target the defined single or multiple objectives/breeding goal.
- Tentative time span for achieving the breeding objective needs to be fixed based on socio-cultural status of the states.
- State may target to encourage the entrepreneurs and private/commercial pig farmers.
- Policies for development of state specific organic pig farms may be taken up.
- State Pig Breeding Policy shall be mandatory for importing States before submission of any proposal for import of exotic breeds of pigs.
- The Policy should target to improve the integration and position of local farmers and entrepreneurs into a pig-production and marketing value chain.

Immediate need/recommendations

- Import of exotic germplasm, specifically, Hampshire, Large White Yorkshire, Duroc, Landrace and Large Black from reputed source after thorough check of bio-security issues.
- Import may be done for live animal instead of frozen semen, as the success rate of frozen semen is not very encouraging.
- Develop breed-specific nucleus hard of imported germplasm for subsequent use in crossbreeding programme.

Proper breeding strategies and establishment of nucleus breeding farm in each district where pig plays a vital role in economy and nutritional security can uplift the socio-economic status of pig farmers. Distribution of superior boars at a subsidized rate to selected breeding farmers or establishment of artificial insemination centre with liquid or frozen pig semen within cluster of pig centric villages would help the farmers to solve the problem of unavailability of quality germplasm. Breeder farmers need to be identified in each village to establish multiplication and breeding farm. Attempts have to be made to establish model pig villages. By framing proper state specific breeding plan, the piggery sector of India can gain momentum.

Department of Animal Husbandry, Dairying and Fisheries, Government of India has initiated the process of development of national guidelines for formulation of state pig breeding policy. Looking to the importance of piggery sector, most recently state Governments of different northeastern states and other pig populated states have initiate formulation and implementation of state specific pig breeding policy.

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Pig - Systematics and Evolution

The pig belongs to the order Artiodactyla (even toed ungulates) with 10 families, 88 genera and more than 200 species. It is estimated that common ancestor of Artiodactyla may have existed around 65 million years ago. The suborder suiformes is perhaps the most primitive lineage among Artiodactyla, sharply differentiated by teeth morphology, stomach structure and function. Hippopotamidae, Tayassuidae and Suidae are the three living families within Suiformes. Most widely spread species of non-ruminant even-toed ungulates belongs to the Suidae family. They are characterized by large canine teeth with usually the curved upper ones, elongated muzzle with snout disc, simple stomach with additional sack and four-toed extremities with well developed side toes. The suidae are omnivores. The living species, grouped under three subfamilies and five genera, are traced to Oligocene era in Europe and given below.

Subfamily Babyrousinae

Genus *Babyrousa*

Species *Babyrousa babyrussa* (Babirusa)

Subfamily Phacochoerinae

Genus *Phacochoerus*

Species *Phacochoerus africanus* (Common Warthog)

Species *Phacochoerus aethiopicus* (Cape & Somali Warthog)

Subfamily Suinae

Tribe Potamochoerini

Genus *Potamochoerus*

Species *Potamochoerus porcus* (Red River Hog)

Species *Potamochoerus larvatus* (Bushpig)

Genus *Hylochoerus*

Species *Hylochoerus meinertzhageni* (Giant Forest Hog)

Tribe Suini

Genus *Sus*

Species *Sus scrofa* (Eurasian Wild Boar)

Species *Sus salvanius* (Pygmy Hog) (redesignated as *Porcula salvania*)

Species *Sus verrucosus* (Javan Warty Pig)

Species *Sus barbatus* (Bearded Pig)

Species *Sus celebensis* (Selawesi Warty Pig)

Species *Sus philippensis* (Philippine Warty Pig)

Species *Sus cebifrons* (Visayan Warty Pig)

The Babirusa (*Babyrousa babyrussa*), meaning pig deer in Indonesian, is significantly different from other Suinae. They are found in Sulawesi and nearby islands where local people used to tame them earlier. It is characterized by small head, almost hairless body and long legs. Their stomach is very complex and grass is the main source of food. Canine teeth in males of the species are very developed, large and curved which sometimes becomes spiral. Their mandibular and maxillary canine teeth are pointed upwards, uncommon to mammals. However, they do not have rooting behaviour. They are very good swimmer. Females usually give birth to two offspring. Their diploid chromosome number is 38 of which 11 autosome pairs, and the X chromosome is almost identical to that of domestic pig.

The Common Warthog (*Phacochoerus africanus*) is so named because of the presence of large warts on their muzzle although its function is not known. The species is wide spread in Sub-Saharan Africa. Their skull shape differs significantly from others pigs. The animal grazes on their knees which commonly causes callouses. They have very less number of teeth and canine teeth are generally large and sharp, present in both the sexes. The common warthog has two and six incisors in the upper and lower jaw, respectively, compared to Cape and Somali Warthog which do not have any functional incisor teeth. Adult weight varies between 50-150 kg. Average litter size varies between three to four piglets. Newly born animals are very susceptible to cold. Their diploid chromosome number is 34.

The Red River Hog (*Potamochoerus porcus*), widely spread in central and southern parts of African continent, is one of the smallest pigs. Their skull is very much similar to *Sus*. Males are characterized by canine apophyses, located between the nose and the ears which looks like two small horns directed towards back, in older males. They are widely variable in colour and size and may have two to three separate species. Adult weight may reach up to 80 kg. Number of offspring ranges between three and four. Their diploid chromosome number is 34.

The habitat of the Bushpig (*Potamochoerus larvatus*) is to the east and south of the Red River Hog and also found in Madagascar. The bristly pelage, extending from head to the whole body gives them a shaggy, crested appearance, distinct from the Red River Hog.

The Giant Forest Hog (*Hylochoerus meinertzhageni*), found throughout the tropical forest region of African continent, is one of the largest wild pigs, particularly of East Africa. Their body is covered with long black hair. The head and muzzle are very broad and the snout is well developed for extensive digging. Their diploid chromosome number is 32.

At present, seven species comprise the genus *Sus*. Wild pigs of this genus are spread to most of the Asia, Europe and northern Africa which were introduced to America,

Australia and Oceania. Domestic pigs are common worldwide except those countries where religious restrictions exist.

The Eurasian Wild Boar (*Sus scrofa*) is one of the most widespread mammalian species and main ancestor of domesticated pigs. At least 16 subspecies are known that are given below.

S. s. affinis	Southern India, Sri Lanka
S. s. algira	North-west Africa
S. s. attila	East Europe, Caucasus northern slope, Western Siberia, Central and Western Asia
S. s. cristatus	Eastern India, western part of Indochina
S. s. davidi	Western India
S. s. leucomystax	Japan
S. s. libica	Asia Minor, Middle east, southern part of Eastern Europe
S. s. meridionalis	South Spain, Corsica and Sardinia
S. s. moupinensis	Eastern China, South East Asia
S. s. nigripes	Southern Siberia, Central Asia
S. s. riukiuanus	Ryukyu Islands
S. s. scrofa	Western, Central and parts of Southern Europe
S. s. sibiricus	Eastern Siberia, Mongolia
S. s. taivanus	Taiwan
S. s. ussuricus	Russian Far East, Korea
S. s. vittatus	Malaysia, Southern Indonesian Islands

The distribution of these subspecies is not markedly different and there might not be sufficient discriminatory differences in term of skull characters, size, colour etc. *S. scrofa* is so ubiquitous because of its ability to adapt varied food and climatic conditions. Pigs can tolerate environmental fluctuation ranging between -50°C - +50°C. *S. sattila* and *ussuricus* attain body weight up to 300 kg. The smallest form of wild boar is from Asia. *S. minor* and *strozzi* were replaced by *S. scrofa* that lived in Biharian fauna. Facial shortening which is common to *S. celebensis* and *scrofa* might be due to their common origin from southern or south-eastern region of Asia.

The diploid chromosome number in *S. scrofa* is 38. The variation in chromosome number among *Sus* subspecies is because of two distinct Robertsonian translocations, *i.e.* T I involving chromosomes 16 and 17 and T II involving chromosomes 15 and 17 that were found in Kirgizian and European boars resulting heterozygotes with 37 chromosomes and homozygotes with 36 chromosomes.

The Javan Warty pig (*Sus verrucosus*) is found in Java, Indonesia. Three warts in specific location of the muzzle is the typical feature which is clearly discernible in adult males of the pig. Size varies greatly and colour varies from black to pale red. Sexual dimorphism is greater than other species.

The Bearded pig (*Sus barbatus*) is so named because of elongated whiskers around muzzle from mouth to ears and found in Malaysian peninsula, Sumatra, Java, Borneo etc. A typical feature is presence of few warts on the muzzle. Mature size is close to *S. scrofa* and weighs approximately 100 kg. They are known to migrate in very large numbers. Fertile hybrids are known with *S. scrofa*.

The Selawesi Warty Pig (*Sus celebensis*) is inhabitant of Sulawesi and other islands including Timor. They are usually small in size with relatively large head, small short ears and short muzzle. Legs are also short. They are usually black with few white and yellowish hair and crown tufts of hair.

The Philippine Warty pig (*Sus philippensis*), found in several islands of eastern Philippines, is smaller than *S. barbatus*. Common colour is black with occasional pale snout band and red brown patches in the mane.

The Visayan Warty pig (*Sus cebifrons*) is found in west central islands of Philippines and occurs allopatrically to *S. philippensis*.

The high degree of morphological similarities, same chromosome number and their homology between all the species of the genus *Sus* suggests their recent origin from a common ancestor. There are more taxa of wild pigs in south east Asia than any other comparable part of the world. However, it is not that simple as it is suggested that different *Sus* species coexist in the same area and yet have maintained significant differences in terms of morphology, behaviour and ecology like in the case of *S. scrofa* and *salvanius* in northern India. Several studies suggest that *S. scrofa* might have originated in Far East and subsequently spread to the west. Robertsonian translocation might have occurred after that. It is further opined that South East Asia and Indonesian islands may have played a significant role in *Sus* speciation and evolution. It becomes clearly evident that pigs were independently domesticated in various parts of the world.

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Pigmy Hog

THE pigmy Hog, *Sus scrofa salvanius*, was first described in 1847 as the only member of the genus Porcula. Subsequently it was classified as a member of the genus *Sus* and a sister taxon of the domestic pig/Eurasian wild boar (*Sus scrofa*). Recent phylogenetic analyses from mtDNA loci revealed alternative phylogenetic hypotheses supporting the original classification of the pygmy hog *Porcula salvania* as a unique genus.

It is found in the dense, moist forests of parts of Asom and Sikkim states of India, Siwalik foothills of Nepal and Bhutan. Pigmy hog is brownish to black, occasionally with some dark reddish stripes. Ears are short and erect upward. The body is covered with thin bristles of average length of 2.25 inch. Animals have 3 pairs of teat. The average length of the animal is 66 cm from snout to rump. The adult weight is 7 to 8 kg. The litter size is usually 3 to 4, and produces two litters a year. The animals survive up to 10 to 12 years.

Pigmy hog stay in herd consisting of 5 to 20 animals together. Males of the herd are ferocious and attack the strangers. The animals are nocturnal in habit. The pig prefers to remain in high grasses and is rarely seen. They thrive on roots and bulbs of forest tree but also eat eggs, young birds, insects and reptiles.

Pigmy Hog at *in-situ* conservation unit

It is highly endangered species due to sharp decline in its population. The species is enlisted in Schedule I of the Wildlife (Protection) Act 1972. *In-situ* conservation of this species in its natural habitat has been started and located in the Manas Wildlife Sanctuary and Baranadi and Nonai Reserve Forests in Darrang district of Asom.

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Breed Descriptor for Registration of Pigs
National Bureau of Animal Genetic Resources
Karnal 132001 (Haryana)

I. GENERAL DESCRIPTION

1. Name of the breed
2. Synonyms
3. Background for such a name/origin
4. Since when the breed is known
5. Strains (or within breed types)
6. Most closely related breeds (in appearance)
7. Classification
   a. Short-eared
   b. Snout-length long or short
   c. Belly type pot or flat
8. a. Native tract of distribution in terms of longitude and latitude
   b. Approximate area of distribution (sq km)
   c. Place(s) State District
9. Estimated population
   a. Year of estimation
   b. Population
   c. Source/Reference
10. a. Communities responsible for developing the breed
    b. Description of community (Farmers/nomads/isolated/tribals)
11. Flock: Average size ...
    Composition: Sows ... % Boars.... % Piglets ..... %
12. Utility of the breed (Pork/Hair/Manure/Others (specify)
13. Any other information

II. PHYSICAL CHARACTERS

1. Colour Male Female
2. Distinctive colour markings
3. Snout profile (straight/convex/slightly convex/concave)
4. Ears (erect/pendulous/horizontal)
5. Coat
   a. Bristle (long/medium/short)
   b. Fineness (bristle diameter)
6. Hoof placement (partial/full)
7. Top line (straight/concave)
8. a. Number of teats
   b. Teat position
9. Any other information

III. PERFORMANCE

1. Body weight (kg)

Weight at	Male			Female		
	Average	Range	N	Average	Range	N
Birth						
Weaning						
3 months						
6 months						
1 year						
Slaughter						
First furrowing						
Adult weight						

2. Body measurements (cm)

Body measurement	Male			Female		
	Average	Range	N	Average	Range	N
Chest girth						
Body length						
Height at withers						
Neck girth						

3. Carcass characters

Carcass characters		Male			Female		
		Average	Range	N	Average	Range	N
Age at slaughter (days)							
Carcass weight (kg)	Hot						
	Cold						
Length (cm)							
Dressing %	Hot						
	Cold						
Meat: bone ratio							
Fat thickness							
Lean %							
Fat %							
Bone %							
Feed conversion efficiency							

2. Body measurements (cm)

1. Reproduction
   a. Males
      (i) Age at first mating (days)
   b. Females
      (i) Age at first oestrus (days)
      (ii) Oestrous cycle duration (days)
      (iii) Oestrus duration (hrs)
      (iv) Age at first mating (days)
      (v) Age at first furrowing (days)
      (vi) Furrowing interval (days)
      (vi) Litter size at furrowing
      (vii) Litter weight (kg)
      (viii) Litter size at weaning
      (ix) Lifetime number of furrowing
      (x) Productive life span (months)

2. Bristle production
   a. Number of cutting per year
   b. Bristle colour

Trait	Age	Male			Female		
		Average	Range	N	Average	Range	N
Bristle weight (g)	1st cutting						
	Later cutting						
Bristle length (cm)	1st cutting						
	Later cutting						
Bristle diameter (i)	1st cutting						
	Later cutting						

6. Any other information specific to the breed

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Annexure IV

History Sheet for Male Pig

GENERAL IDENTIFICATION AND PARENTAGE

Identification Number of animal:

Breed:

Date of birth:

Dam No.:

Sire No.:

EFFICIENCY PARAMETERS

Date of separation from female piglet:

Date of castration:

Date of sexual maturity/puberty:

Weight of sexual maturity/puberty (kg):

Date of first semen collection:

Suitability of semen for insemination: (Y/N)

Weight at 6 months (kg):

Weight at 8 months (kg):

Conformation at 6 months of age:

Culling/disposal date:

Reason for culling/disposal:

Weight at culling/disposal:

COLOUR AND MARKING (IF ANY)

CO-LITTER CHARACTER

Litter character	At Birth	At Weaning
Litter size (no.)		
Litter weight (kg.)		
Individual weight (kg.)		

GENETIC DEFECT (IF ANY)

VETERINARY EXAMINATION

Date	Reason / remarks

Annexure V

History Sheet for Female Pig

GENERAL IDENTIFICATION AND PARENTAGE

Identification Number of animal:

Breed:

Date of birth:

Dam No.:

Sire No.:

EFFICIENCY PARAMETERS

Date of separation from male piglet:

Date of sexual maturity/puberty:

Weight of sexual maturity/puberty (kg):

Weight at 6 months (kg):

Weight at 8 months (kg):

Conformation at 6 months of age:

Culling/disposal date:

Reason for culling/disposal:

Weight at culling/disposal:

COLOUR AND MARKING (IF ANY)

CO-LITTER CHARACTER

Litter character	At birth	At weaning
Litter size (no.)		
Litter weight (kg)		
Individual weight (kg)		

VETERINARY EXAMINATION

Date	Reason / remarks

REPRODUCTIVE PERFORMANCE

Parity	Boar No.	Date of service	Farrowing date	Weaning date	Farrowing interval	Litter size at birth			Litter weight at birth	Litter size at weaning			Litter weight at weaning	Abnormal birth / Dystokia	Remarks
						M	F	T		M	F	T			
1.															
2.															
3.															
4.															
5.															

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SWINE GENETIC RESOURCES OF INDIA

Pig production in India has enormous potential to upscale and contribute to higher economic gains. Pigs have high fecundity, high feed conversion efficiency, shorter generation interval and relatively smaller space requirement. They are equally adapted to intensive and diversified agriculture. Pig farming has the potential to provide employment opportunities to seasonally employed rural farmers mainly in the rain-fed areas and supplementary income generation to womenfolk in their households for improving living standards. Lately, entrepreneurs have started showing interest in pig rearing, processing, value addition and marketing of pork and pork products.

Illustrated or well-documented history of genetic improvement of pigs of the country using exotic pigs is grossly missing. This book is an attempt to present the output of different genetic improvement programmes in the form of development of different synthetic and crossbred pigs, and their impacts are discussed. Finally, an outline of selection and breeding strategies for genetic improvement of pigs for the country in specific is presented. It equally focuses on the conservation strategies for the identified indigenous pig varities and breeds. The book will serve as a ready-reference for the graduate and post graduate students of animal and veterinary science, researchers, policy planners, personnel of line departments engaged in piggery development and NGOs.

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